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CIVIL ENGINEERING.

*Extract from the Report of the Board of Trade on Railways, for the year 1851.—Accidents, their Causes and Means of Prevention.**

On the subject of accidents it is to be observed that 36 passengers have been returned as killed, and 375 injured, during the year 1851; these numbers showing a very great increase as compared with the preceding year, when only 32 passengers were killed and 183 injured.

It must not be assumed, however, that all of these accidents to passengers were accidents arising from causes beyond their own control, and are therefore to be considered as attributable to the dangers of railway traveling; for, upon examining the returns, it appears that during the year 1851 no less than 17 passengers were killed and 20 injured owing to their own misconduct or want of caution, leaving 19 killed and 355 injured as the total number of sufferers from causes beyond their own control.

With respect to the 37 passengers either killed or injured by their own misconduct or want of caution, it appears that no fewer than 24 of these accidents (9 killed, 15 injured,) arose from passengers attempting either to get into or out of trains whilst in motion.

On this subject it may be worthy of observation that during the same period (the year 1851) eight servants of Railway Companies, persons therefore, it may be presumed, in the habit of moving about, more or less, upon engines and trains, were killed, and seven injured from the same cause

*From Herapath's Journal, No. 706.

Such a statement ought to operate as a caution to passengers not to leave their seats or to attempt to get into carriages while the trains are in motion; for if experienced officials constantly employed upon railways meet with such frequent disasters from this cause, it is naturally to be expected that inexperienced people, in making similar attempts to get either upon or off trains in motion, will be much more subject to accidents of this character.

Proper caution on the part of the public in this respect would produce a very material diminution in the list of casualties; and it may deserve consideration whether it might not conduce to this caution if notices were posted conspicuously in stations and carriages, warning passengers of the danger to be apprehended from this improper practice.

After deducting the numbers of those killed or injured by their own misconduct or want of caution, it would appear that during the year 19 persons were killed, and 355 injured, from causes beyond their own control.

This result, giving a total of 374 sufferers, when viewed with reference to the number of passengers conveyed during the year, which amounted to 85,391,095, appears not unsatisfactory, being about four in 1,000,000; but when compared with the returns of the preceding year (1850), it appears that the traffic has not been conducted nearly with the same degree of safety in 1851 as in 1850; for while the number of passengers conveyed has increased in the ratio of about 17 per cent., the number of passengers injured by causes beyond their own control, which may be considered as a measure of the relative safety upon railways during different periods, has more than doubled, the ratio of increase being 104 per cent.

It will be found also, upon reference to the last Annual Report of the Commissioners of Railways, that the casualties in 1850 more than doubled those that occurred in 1849, so that relatively the risk of danger in traveling upon railways appears to have considerably increased.

It is matter of observation that this increase of accidents has taken place concurrently with the extension of the system of excursion-trains, which has been principally developed within the last two years; and it is also to be observed that in the same period the number of persons employed upon each mile of railway open for traffic has decreased, as shown by the returns presented to Parliament, which are made up for the 30th of June in each year, at which date it may be presumed that the excursion traffic is in full operation.

The average number of persons employed upon all the railways in the United Kingdom open for traffic were, on the

30th June, 1849,	10·27	per mile.
29th June, 1850,	9·56	"
30th June, 1851,	9·49	"

It is, however, right to observe that this reduction in the average number of persons employed may be in some degree attributed to improvements in the management of the railways, and to the consideration that the railways which have been opened in late years have traversed less populous districts than the railways first constructed, and have therefore required fewer persons to conduct the traffic upon them.

It has been thought desirable, with a view to ascertaining the causes of

these accidents, and to the consideration of the question whether any remedial measures might not be adopted, either by Parliament or by the Companies themselves, to analyze the reports that have been made by the inspecting officers appointed either by the Commissioners of Railways or by your lordships to inquire into such of these accidents as seemed to call for investigation.

These reports will be found in the Appendix, and have reference to 41 accidents, comprising the whole of the 19 passengers before stated to have been killed during the year by causes beyond their own control, and 319 of the 355 before stated, as the whole number of persons injured during the year from like causes.

In addition to these casualties to passengers, nine servants of railway companies were killed and four injured by the same accidents; so that it will appear that the 41 Reports which are analyzed in the following observations embrace all the more important accidents which have occurred during the year upon the railways of the United Kingdom.

These accidents may be classified under two heads:—

1. Those which arise from accidental failure of machinery, or from defects in the roadway or works.

2. Those which arise from defects in the establishment and management of the railways.

This head may be further subdivided into—

A. Inherent defects in the system upon which the traffic is conducted.

B. Defects in regulations.

C. Inattention to regulations, or inexperience of servants.

D. Want of punctuality.

Of the 41 accidents that have been reported upon, 2 only appear to belong exclusively to the first class, while 25 belong to the second class, and in 14 are involved circumstances falling under both classes.

It is to be observed that accidents very seldom occur upon railways from any one cause, but generally are brought about by a combination of circumstances, each contributing to produce the result.

In 16 of the above 41 accidents were involved circumstances affecting the machinery or works of the railway, and which come therefore under the first head. Two of these only, so far as they could be traced, appear to have been purely accidental, and to fall exclusively under that head; in the other 14 are involved circumstances affecting the establishment and management of the railways.

In five of these latter were involved mistakes, either from carelessness or inexperience at what are commonly termed meeting or facing points at junctions or sidings, showing the importance of reducing as far as practicable the number of these useful but otherwise objectionable contrivances. As at present generally constructed, these points are self-acting; that is, when not held otherwise by hand they are always in one position, being retained in it by weights, and the trains then pass over them always in one direction; after being used to turn trains in another direction, they resume their original position by the action of the weights.

It is to be observed, that if these points act properly there ought to be but little risk in trains passing over them; but if a stone or any other hard substance should chance to get between the movable points and the fixed

rail, the points remain partly open; or if the points, from a jerk of a passing train or from any other cause, shift their position, there is great reason to fear that the train may pass partly along one line and partly along the other. This actually happened to three of the cases referred to, producing most dangerous accidents. It is worthy of consideration whether some means should not be provided by which all meeting or facing points which are passed over constantly by passenger trains shall be fixed at all times, the means provided being such that the fastening could not be applied before the points are completely closed. It is believed that means for this purpose might be provided of a very simple and inexpensive nature.

In four of the cases under the first head it appeared that the locomotive stock was deficient, chiefly in consequence of the engines being overtasked; in two of them that the permanent way was out of repair; in one case a bridge had been partly taken down for alteration, without proper precautions having been taken to warn the drivers of coming engines; and in one case the station accommodation was inadequate for the requirements of the traffic which had developed itself upon the railway.

Under the divison of what has above been termed the establishment of the railways, including its management and staff of servants, it appears that in 27 cases are involved circumstances which come under the Class A., in 13 cases are involved circumstances which come under the Class B., in 23 cases are involved circumstances which come under the Class D. Out of the 27 cases involved circumstances which come under the Class D. Out of the 27 cases in Class A., in which are involved defects that are inherent to the system upon which the traffic is conducted upon railways, it appears that in two cases the luggage placed upon the roofs of the carriages had taken fire; in 24 collisions between trains had occurred, and of these 19 were cases in which trains conveying passengers had come into collision with trains conveying goods; 4 were cases in which passenger trains had come in contact with passenger trains; in one case a goods train with a goods train; and in one case a passenger train with a return engine unaccompanied by a train.

The necessity that exists for trains to traverse railways at different speeds adapted to the particular descriptions of traffic conveyed by them, whether passengers, goods, or minerals, produces a liability to accident from collision which is inherent in the system upon which the traffic of railways is at present conducted, and from which it must be difficult, if not impossible, to free it.

The facts as stated above appear, however, to point to the principal defect of the system, viz., that merchandise and minerals are conveyed over the same lines of rails that are used for the conveyance of passengers.

One remedy for this principal defect of the system, would be the addition to existing railways of lines to be used exclusively for the heavy traffic of goods and minerals. This would mitigate the evil, and much reduce the chances of accident of this nature, but would be generally inapplicable on account of the vast expenditure that would be requisite to carry it into effect, and after all it would only partly remove the chances of collision, which would remain to a certain extent so long as passenger trains traverse railways at different speeds.

Another remedy that suggests itself is, the separation of the two de-

scriptions of traffic, goods and passengers, and conducting them at different times. This practice has been adopted to a great extent on many railways, the goods being conveyed as much as possible by night, so as to interfere with the passenger trains to the least practicable extent.

The third remedy that suggests itself is, that all trains, whether goods or passengers, and all engines which traverse railways, should be worked to well-adjusted time-tables, and that punctuality should be enforced. It will be seen, upon examining the reports, that in 23 of the accidents as to which inquiries have been instituted, it has been ascertained that the trains have been unpunctual or irregular as to time. In 21 of the collisions it appears that irregularity of the trains was one of the concurrent causes which tended to produce them. Upon consideration of the reports it appears wonderful that more of these accidents do not occur; for it is recorded that in some instances goods and mineral trains are sent along railways under the direction of engine drivers, whose only instructions are to proceed to the destination intended for their charge, dropping trucks at stations where necessary and taking up others, without any instructions at all as to time, but with the understanding that they are to get to their journey's end as best they can, so that they deliver the goods at the required places. This understanding or instruction is, however, subject in most cases to certain general regulations, such as, that no train is to follow another within a given time, and that goods trains are to be shunted or moved off the main line when a passenger train is expected within a stated time. Experience, however, shows that these regulations are not sufficient. The interval between trains, as will hereafter be explained, depends upon a number of contingencies, and after all is only to be maintained by the numerous signalmen stationed along the line of the railway, whose responsibility is therefore divided, and not by any of the persons employed upon the train. The shunting of the trains depends upon the unoccupied siding accommodation being sufficient to contain the train at the place where the operation may be necessary, and which is often found not to be the case.

It would appear, then, that the principal guarantee of safety when the traffic is conducted on this system, is the vigilance and superior intelligence of the drivers and persons to whom is entrusted the conduct of the trains.

In some districts where the goods traffic is of a very fluctuating nature, it may be difficult to arrange so that the hours of arrival and departure of all goods trains shall be advertised and known beforehand with the same exactitude as passenger trains; but it is considered, and is found on many railways, that a large portion of the traffic of this nature is as regular and capable of as much exactitude in respect of time as the ordinary passenger traffic. There can be no valid reason why goods traffic of this regular nature should not be conducted on the same principle as the regular passenger traffic, with carefully adjusted time tables, and with punctuality. As to other traffic, which is in addition to the regular or ordinary traffic, and is of a more fluctuating nature, including goods and passengers conveyed by what are commonly termed excursion trains, or special goods trains, it may be well questioned whether a general instruction to

an engine driver to proceed on his journey to his destination, taken in conjunction with the regulation above alluded to, is a sufficient security to the public that the traffic will be conducted with a due regard to the safety of the travelers conveyed by railway.

To be Continued.

Railway Traffic in Great Britain in 1852.*

It appears that the gross traffic receipts of railways in the United Kingdom for the year 1852 have amounted to 15,543,610*l.*, being at the rate of 2118*l.* per mile per annum. The returns published weekly show that 15,088,310*l.* was received on the railways during the past year on 6915 miles, including about 200 miles of canal, being an increase of 520,400*l.* in the receipts over the preceding year on 6537 miles of railway, and also an increase of 378 miles in operation. Independent of these railways, there are about fifteen new lines in operation of an aggregate length of 240 miles, the returns of which are not published weekly, but may be estimated at 181,000*l.* In addition to these there are ten other lines of an aggregate length of 183 miles, belonging to old railway companies who do not publish their traffic returns; but it appears from the half yearly reports that the gross receipts on these lines are about 274,300*l.*, making together 455,300*l.* This sum, added to the published weekly receipts, shows that the gross traffic receipts on the above railways during the past year amounted to 15,543,610*l.*

With regard to the traffic returns published weekly, they show a progressive increase during the past eleven years. In the year 1842, they amounted to 4,341,781*l.*; in 1843, to 4,842,650*l.*; in 1844, to 5,610,980*l.*; in 1845 to 6,769,230*l.*; in 1846 to 7,689,870*l.*; in 1847, to 8,975,671*l.*; in 1848 to 10,039,000*l.*; in 1849, to 11,013,820*l.*; in 1850, to 12,757,985*l.*; in 1851, to 14,567,910*l.*; and in 1852, to 15,088,310*l.* From this it will appear that the annual increase in the past ten years, being on the average more than one million a year, or during the ten years, is 10,746,529*l.* This increase partly arises from the continual development of the traffic on the trunk lines, and partly from the additional receipts derived from the opening of new lines and branches. The increase of traffic in the year 1842 over that of the preceding year, amounted to 500,870*l.*; in the year 1844 to768,337*l.*; in 1845, to 1,058,340*l.*; in 1846, to 1,020,650*l.*; in 1847, to 1,285,780*l.*; in 1848, to 1,083,335*l.*; in 1849, to 954,810*l.*; in 1850, to 1,744,168*l.*; in 1851, to 1,809,925*l.*; and in 1852 the increase over the preceding year amounted to 520,400*l.* The great increase of traffic in the year 1850 was due in a great measure to the encouragement given by railway companies to excursion traffic in that year; and the increase in 1851 chiefly to that cause in connexion with the Great Exhibition. The year 1852 shows a comparative falling off in the increase of traffic as compared with the average of ten preceding years to the amount of 554,252*l.* From this it would appear that the efforts made to force the traffic during the past two years above the ordi-

* From the London Civil Engineer and Architect's Journal, February, 1853.

nary increase had reacted on the traffic of 1852, and thus reduced the expected increase of traffic in that year.

At the end of the year 1842, 1510 miles of railway were open to the public; during the next year an additional length of 56 miles of new railway was opened for traffic; in 1844, a further length of 194 miles was opened; in 1845, 263 miles; in 1846, 593 miles; in 1847, 839 miles; in 1848, 975 miles; in 1849, 834 miles; in 1850, 1096 miles; in 1851, 280 miles, and in 1852 the published returns show an additional mileage of 378 miles. So far as the traffic is concerned, it does not appear that there can be much to complain of in respect of the aggregate amount of it on railways since they have been established, and were it not for the adverse interests operating at railway boards, the errors of engineers as to the cost of works and laying out of lines, the letting of large contracts at exorbitant prices by private agreement, excessive payments for land, the continual litigation both in and out of parliament, and the consequent unwarrantable expenditure on capital account, the traffic receipts would have been ample to pay fair dividends on the outlay.

The average traffic receipts per mile show the effect of opening within a period of four or five years so many miles of branch and competing lines of railway. During the year 1842, the gross receipts averaged 3113*l.* per mile; in 1843, 3083*l.* per mile; in 1844, 3728*l.* per mile; in 1845, 3469*l.* per mile; in 1846, 3305*l.* per mile; in 1847, 2870*l.* per mile; in 1848, 2556*l.* per mile; in 1849, 2302*l.* per mile; in 1850, 2227*l.* per mile; in 1851, 2281*l.* per mile; and in 1852, 2238*l.* per mile. This shows a falling off in the traffic per mile of about 30 per cent.; but during the past three years the receipts per mile have not been much under those of 1849.

The reduction in the receipts per mile would not be of much consequence, provided the average cost of constructing the railways was reduced in the same proportion as the traffic per mile—say from 34,000*l.* per mile to 23,000*l.* per mile, and so on in like manner with every additional line to the system; but, unfortunately, it appears that this would not suit engineers, contractors and other parties; and although some cheap railways have been constructed, the following will show that they have not had much effect on the average cost of the whole:—In 1842, the cost of railways then in operation, including working stock, &c., averaged 34,690*l.* per mile; in 1843, 36,360*l.*; in 1844, 35,670*l.*; in 1845, 35,070*l.*; in 1846, 31,860*l.*; in 1847, 31,700*l.*; in 1848, 34,234*l.*; in 1849, 35,214*l.*; in 1850, 35,229*l.*; in 1851, 35,058*l.*; and in 1852, 34,630*l.* About 5000 miles of additional railways and branches have been added to the system since 1845, at which time the average cost per mile was 35,070*l.*, being only about 440*l.* per mile more than the average cost of 1852. The stationary position of the average cost per mile shows clearly that the continued additions to the capital accounts of old and completed lines of railway far outweigh all the professed advantages of constructing thousands of miles of new railways at less cost than the old trunk lines.

The capital expended on the railways of which the traffic is published weekly amounted in July, 1842, to 52,380,100*l.*; in 1843, to 57,635,000*l.*; in 1844, to 63,489,100*l.*; in 1845, to 71,647,000*l.*; in 1846, to 83,165,100*l.*; in 1847, to 409,528,000*l.*; in 1848, to 148,200,000*l.*; in 1849, to

181,000,000*l.*; in 1850, to 219,762,700*l.*; in 1851, to 229,175,230*l.*; and in 1852, to 239,967,453*l.* The expenditure on the new and old lines above mentioned the traffic returns of which are not published weekly, amounts to about 8,626,100*l.*, making with the 239,967,453*l.*, a total of 248,593,553*l.* expended on 7338 miles of railway, being at the rate of 33,879*l.* per mile. Deducting 45 per cent. for working expenses from the gross receipts of 1852, will leave for interest and dividend 8,548,985*l.*; which on the capital expended would be at the rate of 3·44 per cent. per annum. It is probable that the amount to be divided among the holders of railway shares, bonds, and debentures, after the next half yearly meetings in February, will not be less than 4,500,000*l.*

An Investigation of the Strain upon the Diagonals of Lattice Beams, with the resulting Formulæ. By WILLIAM THOMAS DOYNE, Assoc. Inst. C. E., and WILLIAM BINDON BLOOD, A. B.*

In constructing a model for the purpose of illustrating practically the truth of the mathematical reasoning upon the strains to which the different parts of a lattice beam were subjected under the same and different forms of load, it was the object of the authors to reduce the investigation to as simple a form as possible; they therefore constructed the model with catenated top and bottom strings, connected together by diagonals, forming a single triangulation, purposely avoiding the more complex form of a number of lattices intersecting each other. The arrangement of the diagonals is such as to show, that with a beam supported at each end and loaded at the centre, or uniformly over its entire length, the strain upon the diagonals divides itself at the centre, and is transmitted through the two halves of the beams, in opposite directions, towards the ends, causing the diagonals in each half to act alternately as struts and ties; those acting as struts in the model being made of mahogany bars 14 inches long by 1½ inch wide and ½-inch thick, with their ends simply let into the top and bottom strings, but not made fast in any way; while the ties are made of light hoop iron chains, each in three parts, put together with loose pins passing through them, and fastened to the top and bottom by the iron pins which connect the parts of which they are formed; this arrangement preventing the possibility of the struts acting as ties and *vice versa*.

The length of the model between the points of support is 154 inches (12 ft. 10 in), the triangles formed by the lattice bars are equilateral, each side being 14 inches long, making the depth from centre to centre of the top and bottom 12·124 inches. Its total weight is 22 lbs., and any portion of it can be taken out, so that a dynamometer can be inserted, by which means the strains upon all the parts have been measured and compared with those calculated.

The following are the results (for a beam having a parallel top and bottom):—With a load at the centre, the horizontal strains are greatest at the centre, decreasing towards the ends, in the ratio of the distance from the centre, while the strains upon the diagonals are uniform through-

* From the London Civil Engineer and Architect's Journal, January, 1853.

out the beam. With an uniform load, the horizontal strains are greatest at the centre, decreasing towards the ends, in the ratio of the ordinates of a parabola, while the strains upon the diagonals commence at the centre, increasing towards the end, as their distances from the centre.

The course of reasoning by which these conclusions are arrived at is very simple. The value of the horizontal strains does not require proof here, and those upon the diagonals are easily deduced from them in the following manner:—With a beam supported at each end, and loaded at the centre, the horizontal strain commences at the point of support, increasing uniformly towards the centre, where the connecting rib between the top and bottom is continuous; but when, as in this case, there are intervals between the points of attachment, the increase is sudden at each point of attachment, but of equal value; it is, then, evident, that as the horizontal strains are produced by the diagonals, that by differentiating the known horizontal strains at the points of attachment of the diagonals, the amount of strain due to each diagonal is shown; in this case, the difference between the horizontal strains at each point of attachment is a constant number, consequently the strain upon the diagonals are uniform, or, in other words, the strain upon the diagonals are as the difference between the ordinates of two converging lines, which is the figure which would represent the strains upon the top and bottom.

Fig. 1.

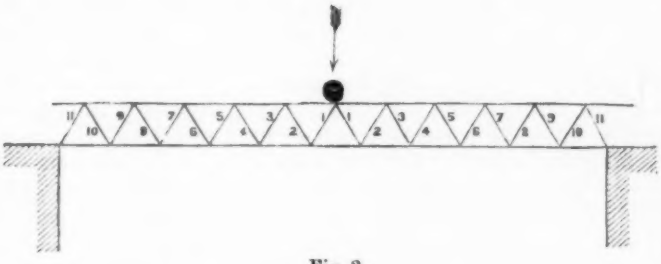
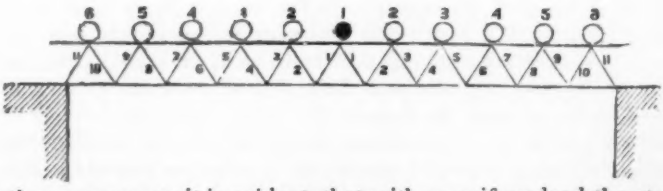


Fig. 2.



For the same reason it is evident, that with an uniform load the strains upon the diagonals decrease from the point of support, where they are greatest, towards the centre, as the differences between the ordinates of a parabola, which differences are the ordinates of two converging lines.

Or the same conclusions may be arrived at without a knowledge of the horizontal strains by tracing, through the medium of the resolution of forces, the strains produced upon the lattices by any given load; when it will appear, that with a load at the centre, as in fig. 1, one half is resolved in each direction, first through the struts 1, 1, thence into the ties 2, 2, and from thence into the struts 3, 3, and so on alternately through struts

and ties until it reaches the point of support; the strain upon each lattice being uniform, and equal to half the load applied, increased by as much as the lattice bar is longer than the perpendicular of the triangle of which it is the hypothenuse. The horizontal strain produced at the points of attachment of each lattice, will also bear, to the strain upon the lattice, the ratio which the length of the base of the same triangle bears to the length of the lattice bar; and the total horizontal strain at any point will be the sum of the strains produced by all the lattices, between the point of support and that point which will give the horizontal strains, as decreasing from the centre to the ends, in the ratio of the ordinates of two converging lines—the premises which were the basis of the last mode of reasoning.

For a beam uniformly loaded, as in fig. 2, weight No. 1 will, in the same manner as in the last example, produce an uniform strain upon all the lattices from 1 to 11, equal in amount to one-half its own weight, increased in the ratio before mentioned; weight No. 2 will resolve the whole of its weight (subject to the same increase) through all the lattices from 3 to 11; weight No. 3, in like manner, will give a new strain from 5 to 11, and so on to the end, the strains accumulating, from the centre towards the ends, as the distance from the centre. Taking the sum of these strains at each point of attachment, the horizontal strains will be found to decrease from the centre towards the ends in the ratio of the ordinates of a parabola, as before assumed. The same reasoning is applicable to the usual lattice beam, where the lattices intersect one another at several points; in this case the horizontal strains are the same, except that they are distributed over a greater number of points of attachment, the strain at each point, however, bearing the same ratio to the others as in the case of the simple triangulation, but the amount is decreased in proportion as the number of points of attachment have been increased.

The following rules and formulæ are at once deducible from the foregoing:—With a load at the centre, the sum of the strains upon the lattices is equal to the horizontal strain at the centre, increased by as much as the lattice bars are longer than the bases of the triangles of which they form the hypothenuses, or the base of this triangle is to the hypothenuse as the horizontal strain at the centre is to the sum of the strains upon all the lattices between the centre and one end; and as in this case the strains upon the lattices are uniform, this total strain, divided by the number of lattices between the centre and the end, will give the strain upon each. For an uniform load, the sum of the strains upon the lattices bears the same ratio to the horizontal strain in the centre, but is differently distributed over them, as before shown; for in this case the whole strain divided by the number of lattices will give the strain upon that bar which is situated half way between the centre of the beam and the point of support, while the strain upon the bar at the point of support is double the strain so found, and the intermediate strains can be calculated accordingly. The strains upon the different parts of the model have been calculated according to these principles from the following formulæ:—

With a load at the centre, the horizontal strain at the centre is $s = \frac{W\,L}{4\,D}$, and at any other point $s = \frac{W\,L}{4\,D} \cdot \frac{2\,x}{L}$, where W = the weight, L = the length, D = depth, and x = the distance of the point

from the abutment; and the strain upon any diagonal is $y = \frac{W\ b}{2\ D}$, where y = the strain, b = the length of the diagonal, and W D as before.

With an uniform load, the horizontal strain at the centre is $s = \frac{W\ L}{8\ D}$, and at any other point $s = \frac{W}{2\ D\ L}(L\ x - x^2)$, where x is the distance of the point from the abutment; and W, D, L, as before; and the strain upon any lattice is $y = W\ \frac{a\ b}{D\ L}$, where y = the required strain, a = the distance of the middle point of the lattice from the centre of the beam, b = the length of the lattice bar, and W, D, L, as before.

These formulæ refer to a beam of a single triangulation, such as the model, the strain upon each lattice decreasing where the lattices intersect one another in the exact ratio of their increased number. The following table shows, in adjacent columns, the strains upon the diagonals of the model, calculated by these formulæ, and those measured by the dynamometer, taken with the weight of the model alone, and also with weights applied in four different forms, by which it will be seen that the calculations agree in a remarkably close degree with the measured results.

Strains upon the Diagonals of the Model, as calculated by the Formulæ, and as indicated by the Dynamometer.

Number of lattice, reckoning from the centre, figs 1 & 2.	Strain with its own weight.		Strain with 77 lbs. at centre.		Strain with 14 lbs. at each point of top.		Strain with 14 lbs. at each point of bottom.		Strain with 7 lbs. at each point of top and bottom.	
	Indicated.	Calculated.	Indicated.	Calculated.	Indicated.	Calculated.	Indicated.	Calculated.	Indicated.	Calculated.
1	—	·6	—	44·6	—	8·7	—	·6	—	4·6
2	1½	1·7	45	45·7	9½	9·8	7	17·9	13	13·8
3	—	2·9	—	46·9	—	27·1	—	19·1	—	23·1
4	4	4·0	47	48·0	28½	28·25	34	36·3	31½	32·3
5	—	5·2	—	49·2	—	45·6	—	37·5	—	41·6
6	6	6·3	48½	50·3	46	46·7	54	54·8	50½	50·8
7	—	7·5	—	51·5	—	64·1	—	56·0	—	60·0
8	8½	8·7	51½	52·7	65½	65·3	73	73·4	69	69·3
9	—	9·8	—	53·8	—	82·5	—	74·5	—	78·5
10	11½	11·0	57½	55·0	87	83·7	95½	91·8	91	87·8
11	—	12·1	—	56·1	—	101·0	—	92·9	—	97·0

By the application of these principles to practice, in bridges or other beams, the correct proportion that each lattice bar should bear to the remainder of the girder is easily ascertained, as also the dimensions of the rivets which connect the lattices with the top and bottom.

If the beam is required to carry an uniform stationary load only, then the lattices may be infinitely small at the centre, increasing in strength

or number towards the ends, as their distance from the centre. If for a load at the centre only, the lattices should be of uniform strength throughout. If, however, as is generally the case in practice, the beam is required to carry both these descriptions of load, as well as one at any other point, then at the centre the lattices should be of such dimensions as to resist the strain produced by the greatest load which can be applied at the centre or at any other point, and to increase towards the ends, so as to meet the highest strains produced by an uniform load.

For girders, having boiler plate or other description of solid sides, the same principles apply, and point out, that for a load at one point only (leaving out of consideration, as in all these other cases, the weight of the beam itself,) the dimensions of the sides, and the connecting rivets, should be uniform throughout; while for an uniform load, the sides and rivets should increase in strength from the centre towards the ends, in the ratio of the ordinates of two converging lines; the correct proportions for any other description of load being also easily estimated by an extension of the same principles.

To be Continued.

LAW REPORTS OF PATENT CASES.

For the Journal of the Franklin Institute.

Supreme Court of the United States.

Lead Pipe Case.

Thomas Otis Le Roy & David Smith, *Plffs. in er.* vs. Benjamin Tatham, Jr., George N. Tatham, and Henry B. Tatham. — *In error to the Circuit Court of the United States for the Southern district of New York.*

This was an action at law, originally tried at New York, before Mr. Justice Nelson, and a jury, in April, 1849. The suit was instituted by the Messrs. Tatham, assignees of John and Charles Hanson, inventors of certain improvements in the manufacture of lead pipe. They alleged that the defendants had infringed upon their rights, under the patent, and had injured them to the amount of $20,000.

A verdict was rendered for the plaintiffs for the sum of $11,748. The case was carried by writ of error, to the Supreme Court of the United States. It was argued before that Court in December last, by Mr. Staples and Mr. Cutting, for the plaintiffs, and by Mr. Gillett and Mr. Noyes, for the defendants.

The facts of the case and the points of argument are fully set out in the opinions delivered.

Mr. Justice McLean delivered the opinion of the court.

This is a case on error, from the circuit court of the Southern district of New York.

The action was brought in the circuit court, to recover damages for an alleged infringement of a patent for new and useful improvements in machinery, for making pipes and tubes from metallic substances.

The declaration alleged that John and Charles Hanson of England were the inventors of the improvements specified, on or prior to the 31st of August, 1837; that on the 10th of January, 1840, the Hansons assigned to H. B. and B. Tatham, two of the defendants in error, the full and exclusive right to said improvements; that on the 29th of March, 1841, letters patent were granted for the improvements to the Tathams as the assignees of the Hansons; that afterwards H. B. and B. Tatham assigned to G. N. Tatham, the remaining defendant in error, an undivided third part of the patent.

On the 14th of March, 1846, the said letters patent were surrendered, on the ground that the specifications of the improvements claimed were defective, and a new patent was issued, which granted to the patentees, their heirs, &c., for the term of fourteen years, from the 31st of August, 1837, the exclusive right to make and vend the improvements secured. The declaration states the patent was of the value of fifty thousand dollars; and that the defendants below had made and vended lead pipe, to the amount of two thousand tons, in violation of the patent, and to the injury of the plaintiffs, twenty thousand dollars.

The defendants pleaded not guilty; the defendant Lowber did not join in the plea, but permitted judgment to be entered against him by default. On the trial certain bills of exceptions were taken to the instructions of the court to the jury, on which errors are assigned.

The schedule which is annexed to the patent and forms a part of it, states, that the invention consists "in certain improvements upon, and additions to, the machinery used for manufacturing pipes and tubes from lead or tin, or an alloy of soft metals capable of being forced by great pressure from out of a receiver, through or between apertures, dies, and cores, when in a set or solid state, set forth in the specification of a patent granted to Thomas Burr, of Shrewsbury, in Shropshire, England, dated the 11th of April, 1820." After describing Burr's machine, its defects, and the improvements made on it as claimed, the patentees say, "pipes thus made are found to possess great solidity and unusual strength, and a fine uniformity of thickness and accuracy of bore is arrived at, such as, it is believed, has never before been attained by any other machinery."

"The essential difference in the character of this pipe which distinguishes it, as well as that contemplated by Thomas Burr, from all other heretofore known or attempted, is, that it is wrought under heat, by pressure and constriction, from set metal; and that is not a casting formed in a mould."

And they declare, "We do not claim as our invention and improvement any of the parts of the above described machinery, independently of its arrangement and combination above set forth. What we do claim as our invention, and desire to secure is, the combination of the following parts above described, to wit, the core and bridge or guide piece, with the cylinder, the piston, the chamber and the die, when used to perform pipes of metal, under heat and pressure, in the manner set forth, or in any other manner substantially the same."

The plaintiffs gave in evidence certain agreements between the defendants, showing the manufacture of lead pipe by the defendant Lowber, for

the defendants Leroy and Smith. And also evidence tending to prove that the said John Hanson and Charles Hanson were the original and first inventors of the improvement described in the said letters patent; that the invention and discovery therein described was new and useful; that the lead pipe manufactured thereby, was superior in quality and strength, capable of resisting much greater pressure and more free from defects than any pipe before made; that in all the modes of making lead pipe previously known and in use, it could be made only in short pieces, but that by this improved mode it could be made of any required length, and also of any required size; and that the introduction of lead pipe made in the mode described, had superseded the use of that made by any of the modes before in use, and that it was also furnished at a less price."

"And the plaintiffs also gave evidence tending to prove that lead, when recently become set, and while under heat and extreme pressure in a close vessel, would reunite perfectly, after a separation of its parts; and that in the process described in the said patent, lead pipe was manufactured by being thus separated and reunited; and that the said John and Charles Hanson were the first and original discoverers thereof; and that such discovery, and its reduction to a practical result in the mode described in said letters patent, was useful and important."

"And the plaintiffs also gave evidence conducing to prove that the improvement described in the letters patent was the same invention and discovery which had been made by the said John and Charles Hanson, and for which letters patent had been granted to them in England, and subsequently in this country, to the Tathams, as recited in the letters patent."

"And the plaintiffs also gave evidence conducing to prove that they had been ready and willing, and had offered to sell the said invention within eighteen months succeeding the issuing of said letters patent to them, and also since; and had, within the said eighteen months, sold the same for a large portion of the United States."

The defendants' counsel then read in evidence from the *Repertory of Arts*, vol xvi. page 344, the description of the patent to the Hansons dated 31 August, 1837. They also read in evidence the patent issued upon the application of the plaintiffs to the Patent Office, containing another specification, which was annexed to the patent surrendered. And also they read the specification of Thomas Burr's patent of 11 April, 1820. Also a patent granted to George W. Potter, described in the *Journal of the Franklin Institute*, vol. xii. published in 1833; they also read the specification of a patent granted in England to Bush and Harvey on 5 Dec. 1817; and also the specification of a patent granted in England to Joseph Bramah on 31 Oct. 1797.

Evidence was also given to show that the combination of machinery for making lead pipe, described in public works as having been invented by Burrows Titus, by George W. Potter, by Jesse Fox, by John Hague, and by Joseph Bramah, were substantially the same as that used by the plaintiffs; that the combination of machinery, patented as herein before stated, by Bush and Harvey, for making pipes of clay, and that used for making maccaroni, were substantially the same as that described in the plaintiffs' patent.

In their charge to the jury the court said, "they, the plaintiffs, also state that they do not claim any of the parts of the machinery, the cylinder, core, die or bridge, but that they claimed the combination when used to form pipes of metal, under heat and pressure, in the way they have described. There can be no doubt that if this combination is new, and produces a new and useful result, it is the proper subject of a patent." The result is a new manufacture. And even if the mere combination of machinery in the abstract is not new, still, if used and applied in connexion with the practical development of a principle, newly discovered, producing a new and useful result, the subject is patentable. In this view, the improvement of the plaintiffs is the application of a combination of machinery to a new end; to the development and application of a new principle, resulting in a new and useful manufacture. That the discovery of a new principle is not patentable, but it must be embodied and brought into operation by machinery so as to produce a new and an useful result. Upon this view of the patent, it is an important question for the jury to determine, from the evidence, whether the fact is established on which the alleged improvement is founded, that lead in a set, or semi-solid state, can thus be reunited or welded after separation. To this instruction the defendants excepted.

It was also objected that the plaintiffs' patent was invalid for want of originality; that the invention had been before described in public works, and Bramah, Hague, Titus, Fox, and Potter, were relied on by the defendants.

To this it was replied, by the court, "that in the view taken by the court in the construction of the patent, it was not material whether the mere combinations of machinery referred to were similar to the combination used by the Hansons, because the originality did not consist in the novelty of the machinery, but in bringing a newly discovered principle into practical application, by which a useful article of manufacture is produced, and wrought pipe made as distinguished from cast pipe." To this charge there was also an exception.

The word principle is used by elementary writers on patent subjects, and sometimes in adjudications of courts, with such a want of precision in its application, as to mislead. It is admitted that a principle is not patentable. A principle, in the abstract, is a fundamental truth; an original cause; a motive; these cannot be patented, as no one can claim in either of them an exclusive right. Nor can an exclusive right exist to a new power, should one be discovered in addition to those already known. Through the agency of machinery a new steam power may be said to have been generated. But no one can appropriate this power exclusively to himself, under the patent laws. The same may be said of electricity, and of any other power in nature which is alike open to all, and may be applied to useful purposes by the use of machinery.

In all such cases, the processes used to extract, modify and concentrate natural agencies, constitute the invention. The elements of the power exist; the invention is not in discovering them, but in applying them to useful objects. Whether the machinery used be novel, or consist of a new combination of parts known, the right of the inventor is secured

against all who use the same mechanical power, or one that shall be substantially the same.

A patent is not good for an effect, or the result of a certain process, as that would prohibit all other persons from making the same thing by any means whatsoever. This by creating monopolies would discourage arts and manufactures, against the avowed policy of the patent laws.

A new property discovered in matter, when practically applied, in the construction of a useful article of commerce or manufacture, is patentable; but the process through which the new property is developed and applied must be stated, with such precision as to enable an ordinary mechanic to construct and apply the necessary process. This is required by the patent laws of England and of the U. States, in order that when the patent shall run out the public may know how to profit by the invention. It is said in the case of the Household Company vs. Neilson, Webster's patent cases 683, "a patent will be good, though the subject of the patent consists in the discovery of a great, general, and most comprehensive principle in science or law of nature, if that principle is by the specification applied to any special purpose, so as thereby to effectuate a practical result and benefit not previously attained." In that case Mr. Justice Clerk in his charge to the jury said, " the specification does not claim any thing as to the form, nature, shape, materials, numbers, or mathematical character of the vessel or vessels in which the air is to be heated, or as to the mode of heating such vessels," &c. The patent was for "the improved application of air to produce heat in fires, forges, and furnaces, where bellows or other blowing apparatus are required."

In that case, although the machinery was not claimed as a part of the invention, the jury were instructed to inquire, " whether the specification was not such as to enable workmen of ordinary skill to make machinery or apparatus capable of producing the effect set forth in said letters patent and specification." And that in order to ascertain whether the defendants had infringed the patent, the jury should inquire whether they "did by themselves or others, and in contravention of the privileges conferred by the said letters patent, use machinery or apparatus substantially the same with the machinery or apparatus described in the plaintiffs' specification, and to the effect set forth in said letters patent and specification."

So it would seem that where a patent is obtained, without a claim to the invention of the machinery through which a valuable result is produced, a precise specification is required, and the test of infringment is, whether the defendants have used substantially the same process to produce the same result.

In the case before us, the court instructed the jury that the invention did not consist, "in the novelty of the machinery, but in bringing a newly discovered principle into practical application, by which a useful article of manufacture is produced, and wrought pipe made as distinguished from cast pipe."

A patent for leaden pipes would not be good, as it would be for an effect, and would, consequently, prohibit all other persons from using the same article, however manufactured. Leaden pipes are the same, the metal being in no respect different. Any difference in form and strength must arise from the mode of manufacturing the pipes. The new property

in the metal claimed to have been discovered by the patentees belongs to the process of manufacture, and not to the thing made.

But we must look to the claim of the invention stated in their application by the patentees. They say, "we do not claim as our invention and improvement any of the parts of the above described machinery, independently of their arrangement and combination above set forth." "What we claim as our invention, and desire to secure by letters patent, is the combination of the following parts above described, to wit, the core and bridge or guide piece, the chamber, and the die, when used to form pipes of metal, under heat and pressure, in the manner set forth, or in any other manner substantially the same."

The patentees have founded their claim on this specification, and they can neither modify nor abandon it in whole or in part. The combination of the machinery is claimed, through which the new property of lead was developed, as a part of the process in the structure of the pipes. But the jury were instructed "that the originality of the invention did not consist in the novelty of the machinery, but in bringing a newly discovered principle into practical application." The patentees claimed the combination of the machinery as their invention in part, and no such claim can be sustained without establishing its novelty—not as to the parts of which it is composed, but as to the combination. The question whether the newly developed property of lead used in the formation of pipes might have been patented, if claimed, as developed, without the invention of machinery, was not in the case.

In the case of Bear *vs.* Smallwood, Curtis 24, R. 1., Mr. Justice Story said, "He (the patentee) says that the same apparatus, stated to this last claim, has been long in use, and applied, if not to chairs, at least in other machines to purposes of a similar nature. If this be so, then the invention is not new, but at most is an old invention, or apparatus or machinery applied to a new purpose. Now I take it to be clear, that a machine or apparatus, or other mechanical contrivance, in order to give the party a claim to a patent therefor, must in itself be substantially new. If it is old and well known, and applied only to a new purpose, that does not make it patentable."

We think there was error in the above instruction that the novelty of the combination of the machinery, specifically claimed by the patentees as their invention, was not a material fact, for the jury, and that on that ground the judgment must be reversed. The other rulings of the court excepted to we shall not examine, as they are substantially correct.

Chief Justice Taney, and Justices Catron and Daniells, concurred. Justices Wayne and Grier dissented, and Mr. Justice Nelson delivered a very able and elaborate dissenting opinion, which will be given in the next number of the *Journal*.

MECHANICS, PHYSICS, AND CHEMISTRY.

On the Composition of the Substances employed by the Chinese in the Manufacture of Porcelain. By MM. EBELMEN and SALVETAT.*

The authors have analyzed a series of substances, collected in China by a resident Catholic priest, Father Ly, which there form the material for the manufacture of porcelain. Some other substances, which are especially used for decoration, were brought from Canton by M. Itier. It results from this investigation that—

1. The kaolins and the *Pe-tun-tse* of the Chinese completely resemble the substances employed by the Europeans for the same purpose. The Chinese kaolins have undoubtedly originated from the decomposition and disintegration of granite rocks. The pe-tun-tse is identical in its mineralogical properties with compact felspar or hornstone, and resembles the pegmatite of Limosin. The pe-tun-tse consists of hornstone reduced to a fine powder, and formed into cakes, which together with the kaolins give the porcelain mass.

2. It appears that the mechanical arrangements for the production of the pastes are the same as with us.

3. The Chinese porcelain clays are more readily fusible than the European, and the same is the case with the Chinese glazes.

The greater fusibility and the greenish color of the Chinese porcelain appears to be owing to an addition of lime to the pe-tun-tse. The pe-tun-tse alone might perhaps serve as a glaze for the porcelain manufactured in France. The Chinese porcelains have been generally considered as peculiarly hard, but they are certainly baked at far lower temperatures than those at Sèvres and Meissen; they are harder than the porcelains with lead glaze. All the following analyses and statements refer merely to the manufacture of porcelain at King-te-tching in Kaiang-si, at which place there are, according to d'Entrecolles, more than 3000 porcelain furnaces and a population of 100,000. Father Ly gives the following account of the manufacture of the porcelain:—

"All the materials employed in the manufacture of porcelain in China are stones which are dug out of the soil or from rocks, with the exception of the *kao-ling* from Tong-kang and from Sy-kang, which are sands; they are suspended in water, in order to obtain the finest powder. All the stones are ground to powder, then diffused in water, in which they are stirred with a rod, and the upper layers of the water drawn off; these deposit the mineral in an exceedingly fine state of division, of which the pastes are formed. All the pastes are brought to King-te-ching into the houses of the workmen, who diffuse them again in water, pass the masses through sieves, dry the sediment somewhat, and then work it. The materials do not occur together in one spot in China; some are brought from very distant places. Some come from Khy-men-hien, others from

* From the London Chemical Gazette, No. 216.

Fou-leang-hien, others from Yu-kan-hien, and even from the province Hou-pe, as for instance the *chy-kao*. At King-te-ching all the finely worked materials and pastes can be bought; but it is frequently necessary to search far and wide in order to procure the raw materials. I have succeeded in obtaining twelve different materials, of which however neither one alone furnishes porcelain. The workmen told me, some of the materials furnished the bone for the porcelain; this is the case with the *kao-lings* from Tong-kang and Sy-kang; others yield the body for the porcelain, as the masses from San-pao-p'ong, from Yu-kan-hien, &c. If the vessels be formed merely from kao-ling, they crack in the fire, because the kao-ling is too hard; if they are made from the other materials without kao-ling, they dissolve in the fire (like flowers which fade in the heat of the sun), because their nature is too weak, and they cannot stand twenty-four hours' fire. I distinguish four kinds of porcelain. To prepare the first, or best kind, 1 lb. of kao-ling is mixed with 2 lbs. of material from Khy-men; for the second, 4 lbs. *say-pe* from Tong-kang and 2 lbs. of *kao-ling* from Sy-kang; for the third, 2 lbs. of material from San-pao-p'ong and 1 lb. of *kao-ling* from Tong-kang; for the fourth kind, 1 lb. of material from Yu-kan-hien with 1 lb. of *hoa-chy* and 1 lb. of *kao-ling* from Sy-kang."

It is quite evident from this letter, that the Chinese, in their manufacture of porcelain, proceed exactly in the same way as we do. They dig up and lævigate the kaolins, the substances from Tong-kang and Sy-kang, and mix them with finely pulverized and lævigated quartz and felspar sand.

Kaolin *from Tong-kang, Province Fou-leang-hieng.*—The crude kaolin furnished by elutriation, 43 per cent. of clay dried between 95° and 104° F., does not effervesce with acids, and resembles the kaolin of St. Yrieix, which is used at Sèvres; it does not fuse in the porcelain furnace, but contracts very much. The residue distinctly shows it to originate from a granitic rock, probably from pegmatite.

Kaolin *from Sy-kang, Province Fou-leang-hieng.*—This contains a very large amount of quartz, and furnishes on elutriation only 7 per cent. of clay. The residue consists in quartz granules and partially decomposed crystals of a rose-colored felspar and golden mica.

The following table of the analyses show the relation of the constituents compared with those of the clay of St. Yrieix. The analyses are made with the washed out clay:—

Kaolin from Tong-kang.		from St. Yrieix.	from Sy-kang.	Quartzose kaolin from St. Yrieix.
Water,	11·2	12·62	8·2	7·2
Silica,	50·5	48·37	55.3	56·9
Alumina,	33·7	34·95	30·3	31·6
Peroxide of Iron,	1·8	1·25	2·0	0·5
Magnesia,	0·8	traces	0·4	
Lime,	..	..	..	0·5
Potash,	1·9	2·40	1·1	3·4
Soda,	..		2·7	
Loss,	0·1	0·40		
	100·0	100·00	100·0	100·1

The great similarity of the Chinese kaolins to those of St. Yrieix is sufficiently evident from these analyses. The French kinds are obtained from decomposed layers of pegmatite, in the neighborhood of which both hard and partially kaolinized felspathic rock occur. The Chinese kaolins undoubtedly originate from granite.

In the following tables are arranged together the results of the analyses of those substances, which, according to the expression of the Chinese workmen, constitute the body of the porcelain. The above kaolins, which impart to the porcelain its infusibility in the fire, they look upon as the bone of the porcelain; all those rocks, which, on the contrary, serve to produce the requisite fusibility of the kaolins and the translucency of the porcelain, are termed the body of the porcelain; they are all of them hornstone, of a conchoidal or splintery fracture, with the hardness peculiar to this mineral. The analyses, so far as it was possible, were made with the same rock in the crude and in the prepared state. The following are the results:—

	Khy-men-hien		San-pao-p'ong.		Siao-ly	
	1. Crude material.	1*. Prepared.	2. Crude material.	2*. Prepared.	3. Crude material.	3*. Prepared.
Loss in the fire,	2·91	3·05	3·10	3·05	3·76	3·25
Silica,	76·20	76·26	74·90	75·00	76·30	76·41
Alumina,	13·60	14·20	14·00	14·15	13·15	13·90
Peroxide of iron,	traces	traces	0·80	0·10	0·85	0·90
Oxide of manganese,	traces	0·35	0·20	traces	0.30	traces
Lime,	0·12	traces	traces	0·12	traces	0·35
Magnesia,	traces	traces	traces	0·15	traces	traces
Potash,	3·28	3·00	3·00	3·10	3·10	3·00
Soda,	5·05	4 00	3·90	3·04	2·17	2·50
	101·19	100·86	99·90	99·71	99·53	100·31

	Yu-kan-hien.			Say-pe.	
	4. Crude material.	4*. Prepared.	4†. Prepared.	5. Crude material.	5*. Prepared.
Loss in the fire,	2·40	2·40	2·60	2·00	2·50
Silica,	74·70	77·00	74·40	75·40	73·60
Alumina,	15·90	15·70	15·00	16·00	17·80
Peroxide of iron,	..	..	traces	0·10	
Oxide of manganese,	0·10	..	..	traces	traces
Lime,	0·10	0·20	0·10	0·40	0·50
Magnesia,	0·20	..	..	traces	0·10
Potash, Soda,	6·40	4·70	6·90	6·00	5.50
	99·80	100·00	99·00	99·90	100·00

The external properties of these rocks, the analyses of which are given in the preceding tables, are as follows:—

1. *Rock from Khy-men-hien.*—Large fragments of a grayish-white rock, of a conchoidal and scaly fracture, spec. grav. 2·64, containing interspersed crystals of quartz, and fusing before the blowpipe into a white enamel; the pieces are coated with dendritic figures of oxide of manganese.

*All those numbers with a * are the prepared materials of the same number; 4 †, a pulverized mixture of rock from Khy-men and rock from Yu-kan-hien, completely prepared.

This material is likewise employed by the Chinese as a glaze; a piece of porcelain, coated with it, and baked in the usual way at Sèvres, acquired a beautiful glaze. Its composition is very similar to that of pegmatite, which is used for glaze in France; the powder obtained by lævigation had the spec. grav. 2.597, and the following composition:—

Water,	0·40
Silica,	76·10
Alumina	15·37
Peroxide of iron,	0·13
Lime,	0·17
Magnesia,	traces
Potash,	2·84
Soda,	4·58
Loss,	0·41
	100·00

2. *Rock from San-pao-p'ong in Fou-leang-hien.*—This is of a gray color, with a splintery fracture, and exhibits, like the preceding one, dendritic figures of oxide of manganese on the fracture. It appears to be somewhat less fusible than the preceding one.

3. *Rock from Siao-ly in Fou-leang-hien.*—A greenish hornstone, with a splintery fracture, and the spec. grav. 2·66.

Some scales of white mica are perceptible in it, and at some places little cubes of iron pyrites. It fuses, like the preceding rock, in the fire of the porcelain furnace.

4. *Material from Yu-kan-hien.*—A grayish rock, with a splintery uneven fracture, with some reddish veins; spec. grav. 2·64; fusibility and appearance nearly like the preceding.

5. *Rock from Say-pe in Tong-kang.*—A greenish hornstone, with a conchoidal and splintery fracture; contains some crystals of iron pyrites; spec. grav. 2·64; and closely resembles the hornstone from Siao-ly (3.); its fusibility appears also to be about the same.

It is remarkable that the Chinese hornstone contains a perceptible amount of water, which is not expelled at 212°.

Hoa-chy.—The substances comprised under this name exhibit the greatest differences according to the localities whence obtained. The authors have examined three kinds; the first is from the collection of Father Ly, the second from the Sèvres collection, and the third was procured from M. Itier.

I. *Hoa-chy from Ngan-jing hien.*—That sent by Father Ly is dug out from the soil and lævigated; according to his statement, it furnishes the inferior quality of porcelain clays when mixed with the above analyzed hornstones and kaolins, and it likewise differs from all hitherto known. In the Sèvres collection there are two samples; one consists of the elutriated clay, the other forms the residue; the first is soft to the touch, has a somewhat yellow color, and does not effervesce with acids; the other consists of agglomerated pieces, of the same color as the clay, mixed with a large number of coarse crystalline particles of quartz.

In the collection of the Ecole des Mines, the authors found the rock

which probably furnishes the hoa-chy on its decomposition; it is labelled "*Rock from the Mountains of Ngan-jing-lao-chan,*" and is a yellow crumbling mass, in which is seen a large number of bipyramidal crystals of quartz. This rock is therefore not a sedimentary one, but a quartzose porphyry. Analysis I. is that of the clayey portion, II. of the sandy portion in the Sèvres collection, III. that of the mineral from the Ecole des Mines. Its difference in composition is owing to its being in a less advanced state of disintegration:—

	I. Clayey portion.	II. Sandy portion.	III.
Water, (loss in the fire,)	9·0	2·9	5·00
Silica,	65·0	85·0	70·00
Alumina,	22·3	9·2	20·95
Peroxide of iron,	2·5	0·6	0·80
Lime,	traces	··	traces
Magnesia,	traces	traces	traces
Alkalies and loss,	1·2	2·3	
Potash,	··	··	3·20
Soda,	··	··	0·90
	100·0	100·0	100·85

II. *Hoa-chy from Koansi* has been placed among the serpentine rocks by Brongniart. According to the examination of the authors, it does not belong there; its composition rather resembles that of halloysite, from which it essentially differs only in the amount of water. Two samples, I. hoa-chy from Koan-sy, II. hoa-chy from Su-chu-en, furnished on analysis—

	I. Hoa-chy from Koan-sy.	II. Hoa-chy from Su-chu-en.
Loss in the fire,	16·50	16·50	15·52
Silica,	48·00	44·00	45·00
Alumina,	32·00	38·50	37·10
Peroxide of iron,	traces	traces	1·20
Lime,	traces	traces	traces
Magnesia,	25·0	1·40	2·10
Alkalies,	1·00	0·64	0·52
	100·00	101·04	101·44

III. *Hoa-chy from Oia-tsia*, sent by M. Itier, consists of large radiate fragments, of a fibrous texture, and with a white fracture. The fibrous nuclei have all the external properties of tremolite; interiorly they are combined with a very soft substance, which appears to be soapstone; the fibrous portion however is by far the most predominant. On being treated with hydrochloric acid, a violent disengagement of carbonic acid results, and the liquid contains lime and magnesia. Its specific gravity is 2·90; it is undoubtedly a mixture of white amphibole with hydrated trisilicate of magnesia, of which soapstone is composed. In the hoa-chy which has not been purified, this mixture occurs together with a certain quantity of dolomite, the amount of which however appears to be variable. According to Beudant, the specific gravity of tremolite is 2·9–3·15, that of steatite 2·6–2·8. This hoa-chy does not fuse nor soften in the porcelain furnace;

it becomes very hard in it, and after the baking scratches glass. On analysis it furnished—

		Oxygen.
Loss in the fire,	1·27	
Silica,	60·79	32·26
Lime,	10·25	2·29
Magnesia,	26·50	10·26
Alumina and iron,	0·40	
	99·21	

Prepared Materials.—The following analyses relate to the pastes prepared by the Chinese, and forwarded by Father Ly, and which on baking furnish the Chinese porcelain. This gentleman collected several mixtures for porcelain of different qualities. Of the following three kinds of best and better quality, experiments which were made in the furnaces at Sèvres have shown that the difference in the quality of these three masses is due to the more or less yellow color which they acquire in the baking. The mass of the first quality burnt very white, whilst the last sample after the baking was perceptibly yellow.

First Quality, (labelled *B. a.*)—This mass is yellowish-white, loses water on calcination, and is partially decolorized; in the porcelain furnaces of Sèvres it burnt perfectly white. It does not effervesce on treatment with acids; hydrochloric acid deprives it of a small quantity of peroxide of iron and alumina, with a trace of manganese. It gave on analysis—

	Crude mass.	Material supposed to have been calcined.
Water,	7·7	
Silica,	63·6	69·6
Alumina,	21·8	23·6
Peroxide of iron,	1·1	1·2
Lime,	0·3	0·3
Magnesia,	0·2	0·2
Oxide of manganese,	0·1	0·1
Potash,	3·0	3·3
Soda,	2·8	2·9
	100·6	100·6

It is highly probable from this analysis that the mass is a mixture of equal parts of chert from Khy-men-hien and kaolin from Tong-kang. The calculation then gives the following composition:—

Water,	7·7
Silica,	63·4
Alumina,	22·7
Peroxide of iron, Lime, Magnesia,	1·1
Potash,	2·6
Soda,	2·5
	100·0

Mass of Second Quality, (labelled *B. e.*)—It consists, according to Ly's statement, of 2 lbs. of material from Khy-men, 4 lbs. of say-pe from Tong-kang, and 2 lbs. of kaolin from Sy-kang, mixed with 2 lbs. of the mass from San-pao-p'ong or Siao-ly. It is probable that the information which

Father Ly gives was obtained from a source which is not trustworthy. According to these statements, the kaolin could only constitute 20 per cent. of the mixture, which would not be very plastic, as the kaolin from Sy-kang contains a large amount of quartz. The analysis gave—

	Crude paste.	Supposed to be baked.
Water,	7·05	
Silica,	65·88	70·0
Alumina,	20·88	22·2
Peroxide of iron,	1·24	1·3
Lime,	0·72	0·8
Magnesia,	traces	traces
Potash,	3·36	3·6
Soda,	2·54	2·7
	101·67	100·6

Third Quality, (labelled *B. i.*)—This mass is said to be formed of 2 lbs. of paste from Sang-pao-p'ong, 1 lb. kaoling from Tong-kang, or of 2 lbs. of material from Yu-kang with 1 lb. kaoling from Sy-kang, or with 1 lb. say-pe or mixture from Hoa-chy. The analysis furnished—

	Crude paste.	Supposed to be baked.
Water,	6·7	
Silica,	68.7	37.3
Alumina,	18·1	19·3
Peroxide of iron,	1·8	2·0
Lime,	6·6	0·6
Magnesia,	traces	
Potash,	2·4	2·5
Soda,	2·2	2·3
	100·5	100·0

The articles manufactured from 1 were very neatly worked, translucent, with a bluish tint; those from 2 were thicker, more blue and less translucent; those from 3 were of a coarse shape, very heavy, scarcely translucent, and with the glaze full of holes.

Plates for the ordinary Porcelains, (labelled *B. o.*)—According to Ly, these are prepared from the residues of the several kinds of pastes, and kaolin from Sy-kang. Their composition is—

	Crude paste.	Paste freed from water.
Water,	9·25	
Silica,	62·80	68·94
Alumina,	19·41	21·30
Peroxide of iron,	3·12	3·42
Lime,	1·04	1·14
Magnesia,	traces	traces
Potash,	3·12	3·42
Soda,	1·72	1·78
	100·46	100·00

The objects manufactured with it are translucent, but rather deserve the name of stoneware than porcelain. The shape is very crude, the glaze not uniform and with holes, the mass coarse and badly ground.

Glazes.—According to Ly, the basis of the glaze is *yeou-ko*, that is,

enamel. This enamel is employed for glazing all porcelains; it is mineral, which is taken from the rocks of Tong-kang, Fou-keang-hien, and is prepared in the same manner as the rock from Khy-men. This yeou-ko is, according to the authors, likewise a hornstone, and related to those the analyses of which have been given above. A sample at the Museum at Sèvres forms a greenish rock with laminar fracture, in which are distributed some crystals of iron pyrites; spec. grav. 2·62. It fuses before the blowpipe to a white enamel. Employed as a glaze on the hard porcelain of Sèvres, it furnished satisfactory results, which were similar to those from Khy-men-hien. The following is the composition of the substance in the crude state, and as prepared by pulverization and elutriation :—

	Crude mineral.	Prepared mineral.
Water,	2·7	2·3
Silica,	75·9	75·9
Alumina,	13·9	14·2
Peroxide of iron,	0·7	0·8
Lime,	0·4	0·5
Oxide of manganese,	traces	0·3
Magnesia,	traces	traces
Potash,	2·9	2·8
Soda,	3·8	3·5
	100·3	100·3

The yeou-ko, or enamel of the Chinese, which is well adapted as glaze for the hard porcelain of Sèvres, is not sufficiently fusible for the Chinese, on which account they mix it with lime, and probably also with the ashes of plants. Father Ly writes that the herb *lang-tchy* is common everywhere in China. A heap is made of alternate layers of this herb and lime, which is then fired; after the burning of the lime, the whole is mixed, treated with water to cleanse it and remove the coarse particles, and mixed finally with yeou-ko. The plants employed are ferns; they leave 0·049 of a reddish ash, which has the following composition:—

Soluble substances,	19·5
Silica,	64·5
Alumina, peroxide of iron, phosphate of lime,	16·0
	100·0

The calcined lime which the authors examined contained a mere trace of substances insoluble in muriatic acid, and was for the greater portion converted into carbonate, but still turned litmus blue. The mixture of this lime with the ashes of the fern is called *yeou-hoe;* it contains only 4 per cent. of a residue insoluble in acids, and 94 per cent. of lime and carbonic acid. As the authors had no prepared glaze at their disposal, which would enable them to determine in what proportion the yeou-hoe was mixed with yeou-ko to prepare the glaze, they analyzed the glaze of two Chinese porcelain plates, and found—

Silica,	68·0	64·1
Alumina,	12·0	10·2
Peroxide of iron,	traces	traces
Lime,	14·0	21·0
Potash and soda,	6·0	5·1
	100·0	100·4

According to this, the amount of calcareous substance mixed with the hornstone is very considerable. To this large amount of lime is owing the ready fusibility of the glaze, and likewise the more or less distinctly blue color shown by the glaze of the Chinese porcelain. It had already been observed, that by the addition of lime to the glaze of the hard porcelain of Sèvres, a decidedly greenish-blue color resulted.

Chy-kao.—A mixture sent under this name by Farther Ly, is a beautiful white fibrous gypsum, containing 21 per cent. of water. According to Ly, this gypsum is a very necessary ingredient to the Chinese for the preparation of their mixtures. According to him, it comes from the mountains of Yu-tchheng-hien, in the province Hou-pe, and is used as an addition in the preparation of the masses, excepting the pastes formed of the kaolin from Tong-kong and Sy-kang, because the powder of all these substances will not form pastes without chy-kao. It is employed in the following manner: In the first place, the powder of the substances is mixed with water, then some chy-kao powder added, and the whole stirred with a rod. After some time the powder subsides, and the water becomes clear. Before the grinding, the chy-kao is placed in the fire, to burn it somewhat; its action however is always the same, whether burnt or not.

The authors observe, that the Chinese at Pekin, in order to render yellow turbid water clear, dip a crystal of alum into it, when all the turbidity is soon precipitated. In the above process the gypsum undoubtedly acts likewise only mechanically, facilitating the subsidence of the suspended particles, as it was not again met with either in the composition of the glazes or the pastes.

In general, the paste of the Chinese porcelain constantly contains more silica and alkalies than that of the European porcelain, and it is far more fusible. Cups from China became soft, and sunk entirely together in the furnaces used for the hard porcelain of Sèvres.

In conclusion, it is worthy of remark, that the Chinese have found that prepared pastes which have long been kept moist furnish the best porcelain; they are said to use mixtures which have been kept moist for a century. Supposing this to be true, it would be owing to the decomposition of the felspar ingredients.—*Ann. de Chim. et de Phys.*, vol. xxxi. p. 257.

(To be Continued.)

For the Journal of the Franklin Institute.

Notes of the Performance of the U. S. Steamer Saranac,

On her late cruize from Philadelphia to Para, Maranham, Pernambuco, Bahia, and Rio Janeiro, and from thence to Pensacola, via. Barbadoes.

Total quantity of coal received on board at Philadelphia and elsewhere,	1159¼ tons.
Total quantity consumed,	1099¼ "
" time during which steam was on boilers,	69 days 13 hours 20 min.
" " " " engines were in motion,	63 " 19 " 57 "
" cost of coals,	$10,517·37
Average cost of coal per ton,	$ 8·88
Distance run by observation,	11039 knots.
Coal per knot,	223 pounds.
Cost of coal per knot,	88·4 cents.

Z.

On the Arrangement of the Materials in the Blast Furnace, and the Application of the Waste Gases. By Mr. Samuel H. Blackwell.*

Continued from page 193.

The manner of taking off the gases at Dundyvan is as follows:—The furnace is 42 feet high, and 12 feet in diameter in the centre; it begins to contract at 12 feet from the bottom, to form the boshes and hearth,—the hearth being 7 feet wide at the bottom; and it also begins to contract at 8 feet from the top, which at the filling plate is eight feet wide. Below the contracted part last named, there are eight flues four feet high, and eighteen inches wide, placed at equal distances from each other, and leading into an annular chamber that extends round the furnace and is continued up to the filling plates, by which it is closed. The pipe for the passage of the gas is placed nearly at the top of this annular chamber. Sometimes the entrances to the flues are covered by a wrought iron cylinder, ten feet wide, resting on a flanch, let into the lining of the furnace at a depth of from five to six feet below the filling plates, so as to leave a circular space between the cylinder and the lining of about twelve inches width. Although this arrangement works satisfactorily, it is doubtful whether the cylinder is necessary, and, indeed, it is more than probable that it would be destroyed before the furnace had been long in blast. In many furnaces with open tops, from which the gases are now taken, the use of the cylinder has been abandoned altogether, as needless. Where not used, it is however quite necessary that the openings into the flues should be at a sufficient depth from the top of the furnace, to prevent the possibility of the admixture of the gas with atmospheric air. To effect this, a depth of ten, twelve, or even fifteen feet, is sometimes adopted with advantage. The gases pass off more readily at these depths, in consequence of the greater resistance of the superincumbent materials, and they are in a more suitable state for heating purposes.

The most able investigations of the nature of the gases of the blast furnace are those of M. Ebelmen, and almost all the knowledge we possess of their chemical composition will be found in a paper communicated by him to the *Annales des Mines*, in 1851, and which contains, not merely a *resumé* of M. Ebelmen's own investigations, but also an examination of those of Messrs. Bunsen and Playfair, as reported to the British Association.

From M. Ebelmen's experiments it would appear that the first action of the blast upon its entrance into the furnace through the tuyeres is to produce carbonic acid, by the union of the oxygen of the atmosphere with the carbon of the coke: this is accompanied with the intense heat required for the fusion of the iron ore. The carbonic acid, as it passes upwards, is converted into carbonic oxide, by contact with the carbon of the incandescent coke above the zone of fusion. As the carbonic oxide ascends higher in the furnace, it acts as a reducing agent upon the oxide of iron of the ore, by uniting with the oxygen, by which a considerable portion is again converted into carbonic acid. The gases emerging from the top of the furnace are therefore, from the result of the chemical action now detailed, and also from the carbonic acid liberated from the

* From the London Journal of Arts and Sciences, January, 1853.

limestone used as flux, more highly charged with carbonic acid than those which may be taken off at a lower point; and consequently, to the extent of this greater proportion of carbonic acid they possess less heating power. Where, therefore, only a portion of the gases are taken off, as in the case of open tops, the depth of the flue is important, in reference to the quality of the gas taken off, as well as to its freedom from any admixture with atmospheric air.

In this notice of Ebelmen's experiments, all attention to the composition of the gases, except in reference to their heating power, is purposely omitted.

The results, at which we may be now said to have fully arrived, are the following:—1st, That the waste gases may be used with great economy in raising steam and heating the blast. 2d, That they must be taken off in such a manner as to prevent their mixing with atmospheric air before they arrive at the place where they have to be applied. 3d, That this may be effected in two ways, either by placing the openings for taking them off sufficiently below the surface of the materials in the furnace, or by closing the filling part entirely. 4th, That the first plan is the most desirable where gray iron is requisite; but, where adopted, it is necessary that a powerful draft should be obtained by a sufficiently lofty stack. 5th, That, when thus taken off as gas, they can be conveyed to any distance proportionable to the power of draft available, without losing any of their calorific power beyond that lost by simple radiation,—the whole of the calorific power to be obtained from their combustion being economized, until atmospheric air is admitted to them at the point where the heating effect is required. 6th, That no arrangement of the filling place should be permitted which reduces that part to less than eight feet diameter, from nine to ten feet, according to circumstances, being generally the most advantageous.

The Chairman inquired whether it had been ascertained what was the temperature of the gases when drawn off from the furnace?

Mr. Blackwell replied that it was not accurately known, but it would not be very considerable, as the gases were not ignited. In one mode of carrying out the principle that was adopted in France, the gases were actually passed through water after leaving the furnaces, to separate all impurities and injurious matter, and also to prevent any risk of explosion. In that case, the only heat lost would be the temperature of the gases in coming from the furnace before they were ignited.

Mr. M'Connell noticed that it was stated in the paper that a greater proportion of carbonic oxide was found at one height than at another, and inquired whether any experiments had been made to ascertain the height from which to get the best result?

Mr. Blackwell replied that from twelve to fifteen feet below the top was the greatest depth that he was aware of such a trial having been made. Carbonic acid was generated at the bottom, as the product of combustion, in the neighborhood of the tuyeres; after rising towards the centre of the furnace, the carbonic acid became converted into carbonic oxide, by taking up carbon from the mass of incandescent fuel, and carbonic oxide prevailed there; but higher still the carbonic oxide reduced the iron ore, and much of it became carbonic acid again. At the top of the furnace there was a considerable proportion of carbonic acid, with a portion of

carbonic oxide; but in the centre of the furnace there was carbonic oxide alone.

Mr. Slate inquired whether, if only carbonic oxide existed in the centre of the furnace, any experiments had been tried for drawing off the gases from the centre, instead of taking them from the top?

Mr. Blackwell did not know of any experiments having been made for taking the gases from the centre of the furnaces; and he believed that fifteen feet from the top was the lowest that had been tried; but it must be observed that, in all probability, if the gases were drawn off at a lower level it would reduce the yield of the furnace; because the carbonic oxide required to reduce the ore of the metal, and it would take away so much of the reducing power of the furnace.

Mr. Slate remarked that the practical effect would then be to shorten the furnace, and to work with a very short furnace was known to be bad. He suggested that perhaps the reduced make of furnaces with closed tops was due to the reduction of the quantity of air entering the tuyeres, on account of the resistance to the discharge from the top of the furnace being increased, which would tend to diminish the quantity of air blown in by the same blast engine.

Mr. Blackwell did not think that was the case, as it was not always the consequence that the yield was reduced by closing the top of the furnace: at Cwm Celyn a rather greater yield was found with a closed top to the furnace than when open. It must be borne in mind, that from the different composition of the ores in different districts, the plan might succeed in one case, when it would not in another.

Mr. Gibbons remarked that the Staffordshire ore required a double proportion of limestone compared to the Scotch ore, and therefore more carbonic acid was generated in the blast furnace.

In answer to questions from the Chairman, Mr. Blackwell stated, that at the Ebbw Vale Works they were raising the steam for the blast engines entirely by the waste gases from the furnaces, and also heating the blast; and for these purposes, from 15 cwt. to one ton of coal would otherwise be wanted for each ton of iron made. The action was found less destructive to the boilers than the ordinary fire; because the heat was very uniform, and the boiler was not exposed either to fluctuations in temperature or excess of heat.

Mr. Slate observed, that the saving of the consumption of slack in South Staffordshire would amount to only 6d. per ton upon the iron, owing to the small cost of the coal usually burnt under steam boilers.

Mr. Blackwell said, that of course there was a great difference in the value of slack with different qualities of coal. In South Staffordshire, from the slack not having a caking quality, it could be used only for steam boilers and inferior purposes; but in South Wales, most of the refuse slack was a valuable material for making coke, which increased its value very much, and made the saving an important consideration. In reply to a question from Mr. W. Mathews, he said that he had had the plan in operation for three years in some furnaces in Derbyshire; and during that time no instance had occurred of repair being required in the hot air apparatus; but it had to be opened about every six weeks to clear away the deposit of dust. He understood, however, that at the Dundyvan Works a con-

considerable loss of heat appeared to be caused by the thick coating of the pipes with dust.

Mr. W. Mathews remarked, that he had lately been over the Dundyvan Works, in Scotland, where the gases had been applied more extensively than elsewhere, and was informed by the manager that he considered they would be as well without this plan, as they found it had a very prejudicial effect on the heating pipes, though less perceptible on the boilers. In Wales, they appear to be using the plan with considerable advantage, on account of the greater price of fuel and coal slack. In South Staffordshire he thought it doubtful that it would be found advantageous. A very slight interference with the regular working of furnaces would be a serious prejudice both to the quality and yield of iron, and would more than counterbalance any economy arising from the application of the gases.

The Chairman inquired what was the nature of the dust that was found to collect so rapidly on the pipes of the hot blast apparatus?

Mr. Blackwell replied, that the chemical character of the dust was not at present well understood; but that the effects alluded to by Mr. Mathews arose simply from the mechanical action of the very large quantity of minute dust given off from the furnace, which could not be cleaned from the surface of the heating pipes so well as from the surface of the boilers, the draft not being sufficient to prevent it from being deposited on the surface of the pipes.

Mr. M'Connell inquired whether the dust could not be removed by drawing the gases through a screen of wire gauze, so as to filter the air before entering the hot blast apparatus?

Mr. Blackwell replied, that the passage for the air from the furnace should be as free as possible, and the wire gauze would cause too much obstruction. In the French works that had been referred to, the air was carried through water to stop all dust and impurities, which appeared to accomplish the object successfully.

The Chairman asked whether Mr. Blackwell agreed with M. Ebelmen's theory of carbonic acid being first produced, then changed to carbonic oxide, and lastly partly converted to carbonic acid again higher up in the furnace? He could not understand such a process.

Mr. Blackwell said he did not consider himself competent to give any opinion upon the chemical changes occurring in the furnace: he considered the theory a probable one, especially as it appeared to be fully confirmed by M. Ebelmen's experiments, in which the gases were taken off at different heights of the furnace, and subjected to careful analysis.

The Chairman said he could not think that the carbonic oxide took up an atom of oxygen from the oxide of the metal: it was a law of chemical affinity, that the second atom combines with less force than the first. He considered it much more probable that an atom of carbon was taken from the carbonic oxide to unite with the iron; he did not think that the carbonic oxide could deoxidize the iron; and he could not understand the two reverse processes taking place at the same time in the furnace.

Mr. Blackwell said that when in the Exhibition, accompanied by M. Le Play (one of the Jurors of the Exhibition, and Professor of Metallurgy in Paris,) and Professor Faraday, he saw some curious specimens, called

'metallic sponge,' which were formed of pieces of iron ore, exposed when heated, to a current of carbonic oxide, or carburetted hydrogen, which deoxidized them. M. Le Play was acquainted with the process before, but it was new to Professor Faraday, who was much interested with the specimens. He (Mr. Blackwell) had not seen the process of deoxidation, but was informed that it was effected by both means, either by carbonic oxide or by carburetted hydrogen.

In the *London Journal of Arts*, from which the above article is taken, it is unaccompanied by any illustrations; we therefore extract the following drawings and their descriptions, illustrating the various arrangements referred to, from the *Civil Engineer and Architect's Journal*, for January, 1853, received since the publication of the article was commenced:

DESCRIPTION OF PLATE VI.

FIG. 1.—*Ebbw Vale, South Wales.—Page* 189.

A, Cylinder resting by a broad flanch on the lining of the furnace.
B, Pipe through which the gases passed off.
CC, An open space, forming a reservoir for the gas.

FIG. 2.—*Cwm Celyn, South Wales.—Page* 191.

AA, Two cast iron bearers, (only one of which is visible in the section.)
B, Cone of cast iron.
C, Short cylinder, suspended from the filling plate.
D, A second cylinder, resting on the base of the cone.
E, Pipe for the passage of the gases.

FIG. 3.—*Ebbw Vale, South Wales.—Page* 191.

A, An inverted truncated cone.
B, A cone closing the end of the cone A.
C, Pipe for the passage of the gases.

FIG. 4.—*Page* 192.

A, Lid or valve upon the main gas pipe, B.
B, Main gas pipe.
CC, Gas pipes.
E, Covering of gas pipes, CC.

FIG. 5.—*Dundyvan, Scotland.—Page* 245.

AAA, Flues leading into annular chamber.
BB, Annular chamber running round the furnace.
C, Pipe for the passage of the gases.

Fig. 6, shows the arrangement adopted for taking off the gases at a furnace recently erected at Pontypool, and in which it will be seen that the use of the cylinder is abandoned. In reference to this latter point, it is necessary to consider briefly the composition of the gases, and the chemical changes taking place in the furnace.

For the Journal of the Franklin Institute.

On the Analysis of Cast Iron. By Professors CAMPBELL MORFIT and JAMES C. BOOTH.

(Extract from the Official Report to Captain L. A. B. Walbach, U. S. Ordnance, on Foundry Service, upon the Examination of Gun Metal.)

(Continued from page 202.)

Calcium; Magnesium; Sodium; Potassium; Cobalt; Nickel; Iron; Manganese; Aluminum; Copper, and Phosphorus.

Another portion of metal is required to be digested for the estimation of these components, because the filtrate from the carbon, by digestion with

iodine does not contain all the phosphorus and alumina, as has already been stated. The filtrate from the digestions in hydrochloric acid for allotropic carbon and for silica and slag have also lost a portion of their phosphorus, which during the digestion passed off as phosphuretted hydrogen gas. Moreover, some of the above constituents are in such small proportions that they cannot be determined in one gramme, the quantity used in the forementioned digestions. The proper course therefore is to proceed as follows:

6th, Five grammes of clippings of metal are placed in a beaker of eight ounces capacity, drenched with fuming nitric acid, covered and set aside in a cool place; for if heated immediately, the reaction would be so violent as to eject particles. After twelve hours, pure nitric acid is added, and the beaker transferred to the extreme end of the sand bath, so that it may not be subjected to a higher heat than 212° Fah., as phosphoric acid will volatilize above that temperature, from solutions containing free acid.

When the solution is perfect, as may be known from the flocculent appearance of the insoluble particles, the cover is removed and the liquor allowed to evaporate gradually to dryness. Hydrochloric acid is added, the cover replaced, and digestion continued until re-solution is effected.

The addition of hydrochloric acid is necessary to insure the entire solution of all the oxide as well as basic salt which are formed by the nitric acid, but are insoluble in it or in water alone; besides, some phosphide of iron, which can only be entirely dissolved in hot aqua regia, may otherwise remain, because of its insolubility in nitric acid alone. Hydrochloric acid alone would not answer; for, as before stated, it would dissipate most of the phosphorus, as phosphuretted hydrogen gas.

By this prolonged treatment, which, if pursued as we have directed, causes no loss of phosphoric acid, the iron, chrome, manganese, aluminum, calcium, magnesium, sodium, potassium, cobalt, nickel, and copper are entirely dissolved and remain in the liquid; while the subsident matter contains part of the carbon, all the silex and slag, together with tin and titanium, as oxides, if the latter are present in the metal. It is requisite that the hydrochloric acid used in the redigestion be strong, otherwise the alumina which loses its acid by evaporation becomes difficultly re-soluble. As dense metallic solutions, particularly when acid, are apt to clog the filter, the liquid is next to be diluted with water, so as to facilitate the filtration, then filtered through fine paper, and well washed with hot water. The filtrate is A, the filter *a*. The latter is set aside for subsequent treatment for tin and titanium.

To the filtrate A, aqua ammonia free from carbonate is added in excess. Alumina, and the oxides of chrome, manganese, and iron, with phosphoric acid, are precipitated, while lime, magnesia, cobalt, nickel, copper, sodium, and potassium remain in solution. The presence of ammonia in excess holds up the copper, cobalt, and nickel, and of ammoniacal salts, as a general rule, also retains the manganese in solution as well as the magnesia; but where the iron with which the manganese is associated is so largely in excess, as in the present instance, the latter is wholly precipitated with the former. Of numerous essays, there are very few in which even traces were left. If the solution is not acid previous to the

BLAST FURNACES.

Apparatus for collecting the waste gases.

Fig. 1.

Ebbw Vale, South Wales

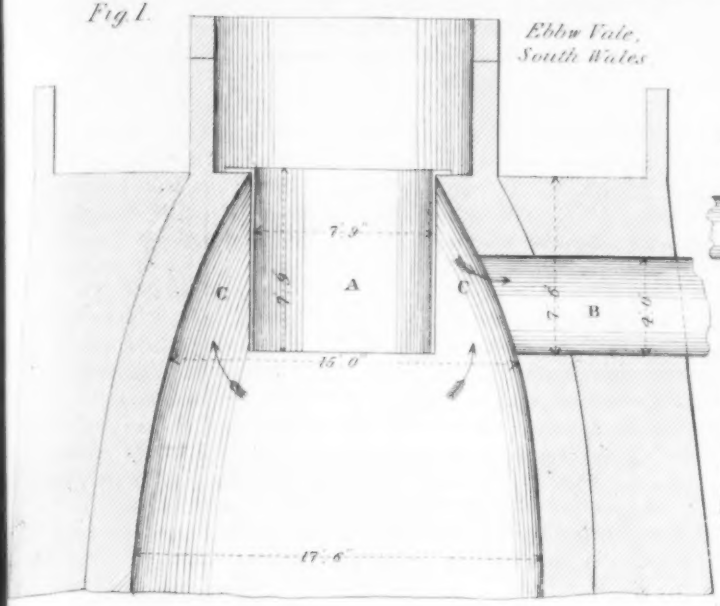
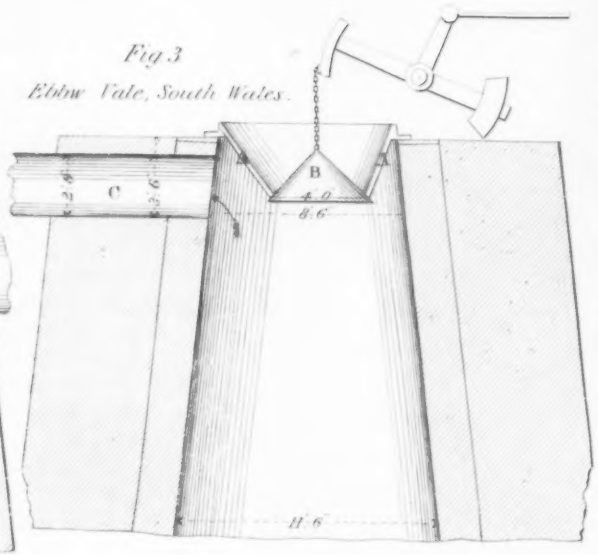


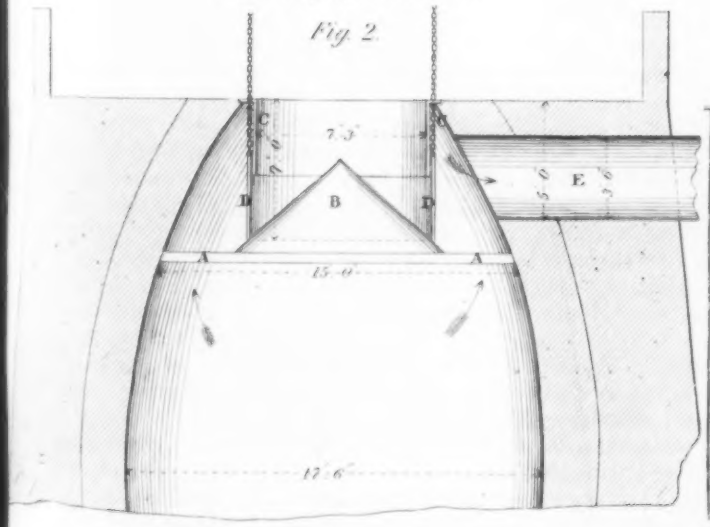
Fig. 3

Ebbw Vale, South Wales.



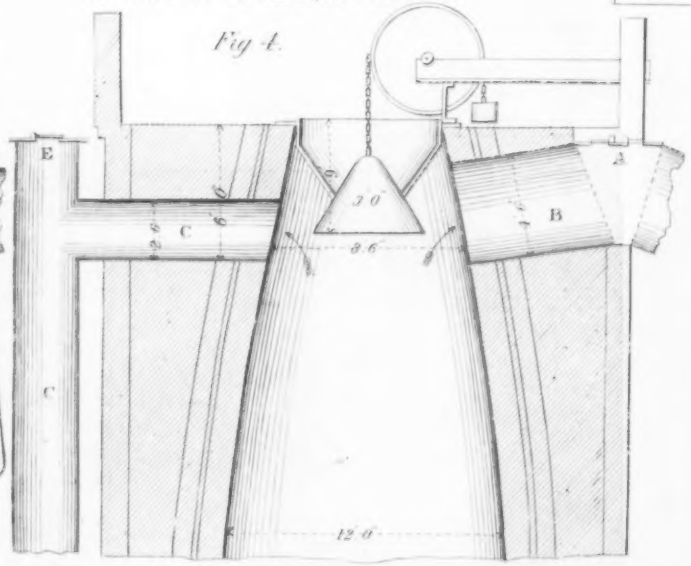
Cwm Celyn, South Wales.

Fig. 2.

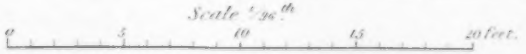


Bilston New Furnaces, Staffordshire

Fig. 4.



Scale 1/96th



Cases from

BLAST FURNACES.

Pontypool, South Wales.

Fig. 6.

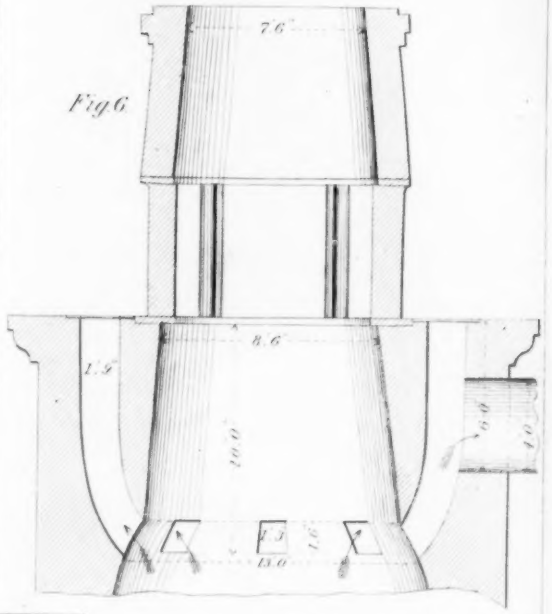
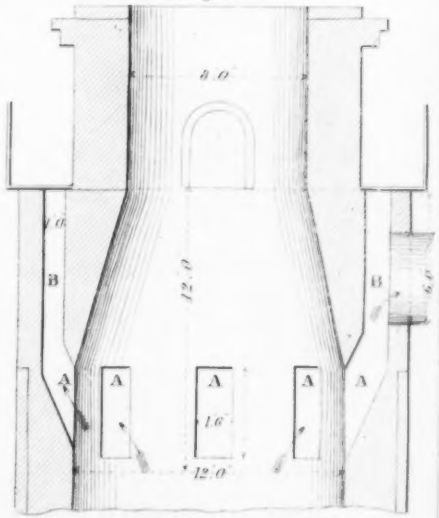


Fig. 5.



Dundyvan, Scotland.

addition of aqua ammonia, some muriate of ammonia must be added. Immediate filtration should always follow the treatment with aqua ammonia, to avoid the transfer of carbonic acid from the air to the lime, and the consequent precipitation of carbonate of lime. The filter is well washed with hot water, and set aside as *b* for the present.

Calcium.—The filtrate B will have a bluish tinge, if any copper is present, and is to be evaporated to a dense solution, mixed with twice its volume of absolute alcohol, and the lime precipitated by a few drops of sulphuric acid. The sulphate of lime is filtered off, washed with dilute alcohol, ignited, weighed, and the amount of calcium calculated from the sulphate.

The filtrate from the lime is then evaporated very cautiously to dryness, and heated to expel every trace of ammoniacal salt; in case the sulphuric acid should be in excess, it is well to neutralize it with a piece of carbonate of ammonia, to be added after the evaporation and previous to the heating, which must be to slight redness, and continued until the weight of the crucible and contents remains constant. This expresses the weight of the sulphate of potassa, soda, and magnesia, with traces of copper, cobalt, and nickel, if they should be present.

The saline mass is dissolved in water and the solution divided into two equal portions. In the analyses of some silicates, a small insoluble residue is apt to be left in making this solution, and it chiefly consists of manganese and silica, but in the present analysis such residue is not observed.

One portion of the solution is treated with chloride of barium, to precipitate sulphate of baryta from the weight, of which the sulphuric acid, doubled, expresses the whole amount of this acid in the joint weight of the sulphates above determined. The excess of baryta being removed from the solution by sulphuric acid, sulphuretted hydrogen is passed through the solution, whereby sulphide of copper if present is precipitated.

Copper.—The sulphide of copper and sulphate of baryta are filtered off, and the copper determined if necessary by re-solution of the sulphide in nitro-muriatic acid, after removal from the paper, and by precipitation when boiling, by potassa. The solution filtered from the sulphide of copper, is tested for cobalt and nickel by adding ammonia and a few drops of sulphide of ammonium, and then acidulating carefully with hydrochloric acid; a black sulphide remaining indicates cobalt or nickel, and may be further tested; but we have hitherto only found traces of these metals in the present analyses.

Magnesium.—The second portion of the solution of joint sulphates is treated with ammonia and phosphate of soda, whereby the ammonia-phosphate of magnesia is thrown down; it is filtered, washed with ammoniacal water, dried, burned off, and the amount of magnesium calculated from the weight of the phosphate of magnesia, which is to be doubled.

Having determined the magnesia and the total amount of sulphuric acid in the joint sulphates, the relative amounts of potassa and soda may be calculated by indirect analysis or by a simple equation; by calculating the amount of sulphuric acid required by the magnesia, which happens to be just twice its weight, and subtracting this from the total amount of sulphuric acid in the joint sulphates, we have the amount of sulphuric acid, *s*,

combined with the alkalies. Further, by subtracting the weight of the sulphate of magnesia from that of the joint sulphates, we have the weight of the alkaline sulphates, from which, if their sulphuric acid be taken, the remainder is the joint weight a of the alkalies. Then $2{\cdot}9136\,a - 2{\cdot}258\,s =$ the weight of potassa. This subtracted from a gives the weight of soda. The metals potassium and sodium are calculated from the weights of their oxides. This method of indirect analysis we have found practicable, when the quantities to be weighed are such as to throw the errors of observation into the hundredth place, and when there is not too great a preponderance of one alkali.

In our first essay, we separated the lime from filtrate B with oxalate of ammonia, filtered it off, evaporated the filtrate in a porcelain capsule, under paper cover to avoid dust, ignited to expel ammoniacal salts and chlorine from magnesia, and towards the end added a little oxide of mercury, to insure the expulsion of the last trace of chlorine that might remain, and again heated to redness, to drive off excess of mercury. The magnesia was thus oxidized and rendered insoluble, while the residual components remained soluble. The capsule and contents having been weighed and the weight of capsule deducted, the remainder was noted as the gross weight of magnesia, alkalies, cobalt, and nickel. The latter three being as chlorides, the proportion of radicals was calculated accordingly.

The presence of cobalt and probably nickel was recognised in this method, by the pink tinge in the evaporated saline mass, but their quantity was too small to determine. The soluble matters were dissolved out by hot water, and the insoluble magnesia separated by filtration, dried, ignited, and weighed; its weight deducted from the gross weight of the magnesia and alkaline chlorides, gave the amount of the latter, whence was calculated their proportion of radicals.

It is very difficult, even with the most skilful manipulation, to prevent a partial volatilization of the alkaline chlorides at the temperature necessarily used in the ignition, especially in a current of air and where a quantity of ammoniacal salt is sublimed, but yet it has hitherto proved the more accurate method.* Since however the quantities of alkali in these analyses proved exceedingly small, we preferred the former process, and determined only the joint amount of potassa and soda.

The contents of filter b, consisting of oxides of manganese, chrome and iron, with alumina combined with phosphoric acid, are carefully transferred from it with a porcelain spatula to an eight ounce beaker glass; the filter is washed with hot water, dilute hydrochloric acid, and lastly with hot water, to remove every trace of iron solution that may be retained in the pores of the paper.

This process of solution by displacement of the portions of iron adhering to the filter saves time, trouble, and loss, as it reduces the number of filtrations which would otherwise be necessary if the filter with its contents had been jointly digested.

The filter, containing nothing, is rejected. The filtrate, holding in solution the entire contents of the filter, is to be neutralized with aqua ammo-

* The recent method of Lawrence Smith, (*Am. Jour.*,) is an important improvement in the removal of ammoniacal salt.

nia and then treated with a slight excess of hydrosulphide of ammonium, and immediately afterwards with two fluid drachms of caustic potassa solution of specific gravity 1·30. All the iron as well as manganese precipitates as sulphide; but the alumina and chrome are retained in solution by the potassa. As soon as the precipitate has wholly subsided, but not until then, and it is therefore well to promote the separation by gently warming the liquor upon the ledge of the sand bath, the clear supernatant liquor is filtered off, and six fluid drachms of caustic potassa solution of 1·30 added to the sediment, and the whole digested for a few minutes on the sand bath to insure the removal of every trace of alumina and phosphate. It is then diluted with water, filtered on the same filter as employed for the first liquid, and washed with dilute hydrosulphide of ammonium to prevent the formation of soluble sulphide of iron by the action of air and water. The filtrate is c and the filter *c*.

The filter *c* contains iron and manganese as sulphides, and its contents must be digested in nitric acid, filtered and washed to separate any unoxidized sulphur. Hydrochloric acid cannot be substituted, for the nitric, as it is absolutely necessary that all the iron shall be in a state of peroxidation, because, if any of it is protoxide, it remains in solution with the manganese and leads to error. If the potassa was not entirely removed from it by hot washing previous to the digestion, it will now exist in the liquor as sulphate and nitrate, and being an impediment to the after steps of the process must be removed. This is done by precipitating the iron and manganese by ammonia, washing with hot water, and redissolving in hydrochloric acid. When the solution has become cold it is ready to be treated for the separation of the manganese from the iron, which is accomplished by adding a slight excess of pure carbonate of baryta portionwise, setting aside for twelve hours at the ordinary temperature, and stirring occasionally during the interval. When the reaction is completed, all the iron has precipitated, while the manganese remains in solution. The whole is to be filtered and washed with hot water. The filtrate is D and the filter *d*. The filtrate D is frequently cloudy, owing to the intimate suspension of particles of carbonate of baryta and iron precipitate which passed through the filter, and these must be separated, to prevent their contaminating the manganese by after solution in acid. The solution is therefore evaporated to one-fourth its volume, and the suspended matters, whose subsidence is thus effected, filtered off and added to the filter *d*. The evaporation answers the double purpose of concentrating the liquor sufficiently to insure the entire separation of the baryta salt, which is then removed by the addition of sulphuric acid, filtering and washing with hot water. The filtrate is further evaporated under paper cover, tested with a drop of sulphuric acid, to be assured of the absence of baryta, and treated with a clear solution of carbonate of soda in slight excess. The whole is well warmed in the sand bath, the precipitated manganese filtered off, washed with hot water, ignited until the weight remains constant, and the amount of metal deduced by calculation. The manganese is precipitated as carbonate, but when highly ignited in contact with air, like all the other oxides of manganese, it becomes manganoso-manganic oxide, (MnO, Mn^2O^3,). To reach this state it requires prolonged treating and consequently the ignitions and weighing must be repeated

twice or thrice, as may be necessary, to ascertain when this condition is reached.

Iron.—The contents of filter *d*, consisting of pure oxide of iron with excess of carbonate of baryta, are transferred with a platinum spatula to a beaker glass, and the traces adhering to the filter displaced by hydrochloric acid and hot water, as directed before. After digestion with a little more hydrochloric acid until solution is complete, sufficient sulphuric acid is added to precipitate all the baryta salt as sulphate, which is then filtered off. Before filtration, it is better to allow repose, so that the precipitate may subside and have a clear supernatant liquor. This passes the filter very readily, and when all of it has gone through, the pasty residue should be drenched with hot water, poured upon the filter, and washed with hot water. The filtrate is less apt to be cloudy by this mode. A drop of sulphuric acid is to be added to the filtrate to obtain assurance that there is no baryta retained in the solution. Beakers should be exclusively used as containing vessels in these separations of baryta, for glass shows much more readily than porcelain, whether any suspended particles cloud the filtrates.

As the sulphate of baryta, precipitated from the iron solution, tenaciously holds a portion of the latter, the former must be well washed in the filter, first with hydrochloric acid, and then with hot water.

The consecutive addition of hydrochloric and sulphuric acids to the contents of filter *d*, is much better than the seemingly shorter plan of adding sulphuric acid direct and alone, to the filter, and displacing the iron as soluble sulphate, while the insoluble sulphate of baryta remains upon the paper. The latter mode endangers the carbonization of the filter, and the introduction of soluble organic matter into the liquid, which would in a subsequent stage prevent the entire precipitation of the oxide of iron.

The clear iron solution freed from baryta is to be treated with aqua ammonia in slight excess, and the precipitated oxide of iron filtered off and washed well with hot water; the filter is then thoroughly dried in the air chamber, its contents detached, and the two ignited separately in a platinum crucible, to prevent reduction of oxide by the carbon of the filter. The metallic iron is then calculated from the weight of Fe^2O^3.

Our experience proves that manganese is separated from iron in a satisfactory manner by carbonate of baryta; but certain precautions are necessary to success.

At least twelve hours must be allowed for the precipitation of the iron after the addition of the carbonate of baryta, and to be satisfied that all has gone down, it is better to test a drop of the clear supernatant liquor with sulphide of ammonium.

As sulphate of baryta is very liable to pass through the filter, care must be taken in every such event to promote its deposition by warmth and to separate it by refiltration.

Manganese is generally separated from iron, when there are no other associates, by carefully neutralizing the hydrochloric solution of the two with aqua ammonia, and then adding succinate of ammonia, the first to retain the manganese in solution, while the latter precipitates the iron. But when the iron is largely in excess, it is impossible to prevent the manganese going down wholly, or nearly so, with it; even although the exact point

of neutralization by ammonia, a very nice manipulation, is attained previous to adding the succinate. Besides, the wash water, especially if warm, may induce the formation of soluble acid succinate of iron and carry away a portion of it through the filter. In the ignition of the succinate there is also a difficulty in preventing the carbon of the succinic acid reducing a little of the oxide of iron, when the quantity of the succinate of iron is large. This latter objection may however be partially obviated by washing the filter with cold ammonia instead of hot water.

Herschel's method with carbonate of ammonia founded upon the fact that Fe^2O^3, of the neutral per salts of iron is precipitated from the solutions of these salts by boiling, whilst oxide of manganese remains in solution, and Scherer's, with caustic potassa, which is a modification of it, have also the disadvantage of requiring difficult manipulation and very exact pre-neutralization to insure the precipitation of the one and the retention of the other (*Rose* ii. 93).

Henry's process, (*Journ. de Chim. Med.* 1850,) without yielding any more accurate results than the carbonate of baryta plan, is tedious and time consuming; moreover, as organic matter is used the manganese may be partly retained in solution as protoxide, and its correct estimation subsequently prevented.

The filtrate c contains the greater part of the phosphoric acid, in combination with the potassa which was added with the hydrosulphide of ammonium; the remainder, which is a very minute portion, is, with the alumina as a very basic compound, held in solution by the potassa.

In most of the processes heretofore followed by chemists, in the analysis of cast iron, the obstinate affinity of phosphoric acid for alumina has been overlooked, and that portion of it combined with the alumina, owing to the difficulty of separating it, disregarded in the determination of phosphorus.

If any excess of hydrosulphide of ammonium was added, it remains in the filtrate, and the latter must therefore be digested with nitric acid for some hours, below 212° Fah., to expel ammoniacal salt and promote the subsidence of unoxidized sulphur, which after twelve hours repose must be filtered off. It is not advisable to take the shorter method, after adding the acid to separate sulphur, and pour in aqua ammonia to throw down alumina with the sulphur, hoping to expel the latter during ignition; for sulphur first precipitated redissolves under these circumstances; care must also be observed to keep the heat always below 212°, or there will be loss of phosphoric acid by volatilization.

After the sulphur is separated by filtration, the filtrate is to be treated with a slight excess of aqua ammonia, the vessel covered with paper, and heated upon the sand bath; after a time cloudiness ensues, and alumina falls down, and must be filtered off, washed with hot water, and set aside as *e*; the filtrate is E.

Phosphorus.—The filtrate E contains only alkaline phosphates, and after being supersaturated with hydrochloric acid, is then to be treated with a nitric solution of ·5 gramme of fine iron wire, carefully precipitated by aqua ammonia, filtered, the filter washed with hot water, dried and ignited (paper separately), and weighed. The excess of weight over the amount of Fe^2O^3, that ·5 gramme of iron should form by solution in

nitric acid, is the amount of phosphoric acid which the quantity of phosphorus in the filtrate makes;—hence the latter may be deduced by calculation.

To separate the remaining traces of phosphoric acid from the aluminous precipitate, the latter must be dissolved in hydrochloric acid, and treated with tartaric acid until the solution ceases to give any precipitate by aqua ammonia. The tartaric acid prevents the precipitation of the phosphate of alumina by the ammonia. When barely supersaturated with aqua ammonia, a solution of sulphate of magnesia is added, containing so much of muriate of ammonia as will prevent the precipitation of the magnesia by the caustic ammonia. The magnesia carries down the phosphoric acid as triple phosphate, from the alumina, the solubility of the latter being promoted by the tartaric acid; after several hours repose it is filtered, washed with ammonia water, dried, ignited, weighed, and the amount of phosphorus calculated. It is added to that obiained from filtrate E.

Aluminum.—The alumina is next determined by evaporating the filtrate to dryness, burning off to charcoal, fusing the balance with bi-sulphate of potassa, to destroy the remaining carbon and render the alumina soluble, redissolving in hydrochloric acid, precipitating by carbonate of ammonia, washing with water, igniting, and weighing.

Where a larger quantity of phosphoric acid and alumina is to be separated, it is a safer plan to redissolve the alumina, and treat it again in the same way with tartaric acid, magnesia, &c.; but we have not found it necessary in the present analysis. The alumina obtained is tested for chrome.

This method has been found to give the most reliable results. The separation of phosphoric acid from iron alone may be readily effected by several methods; but when alumina is an associate of the iron, then the task is very difficult, owing to the similarity of behavior of alumina and its phosphates to reagents, the affinity of phosphoric acid for alumina being very obstinate.

The process at first followed by us with great confidence was that of Berzelius, with some modifications by Rose and ourselves, and we only abandoned it, after numerous and repeated essays had convinced us of its unreliability. The iron, after the separation of the manganese and every other component, except phosphoric acid and alumina, was dissolved in hydrochloric acid, supersaturated with carbonate of soda, evaporated to dryness, transferred to a platinum crucible, mixed intimately with two parts of impalpably fine and pure silex, and six parts of carbonate of soda to every one of phosphate, and the whole highly heated to fusion for half an hour.

The silica is added to detach the phosphoric acid from the alumina, while a part of the carbonate of soda combines with it at the moment of elimination to form phosphate of soda. The remainder of the carbonate of soda unites with the excess of silica. There are two affinities simultaneously exercising their preference, and thus the phosphoric acid as soon as eliminated by the silica, which unites in turn with the alumina it has displaced, is embraced by the carbonate of soda. Carbonate of soda alone would not answer, for though it will by *fluxing* remove phosphoric acid from iron, it does not separate it from alumina.

After fusion, the fluxed mass was emptied from the platinum crucible into a silver capsule, and repeatedly boiled with water, filtered after each boiling, and the several liquors or filtrates united; the filter 1 contained the oxide of iron and alumina, with free and combined silica: the filtrate 2 held in solution the phosphorus as phosphate of soda, the excess of carbonate of soda, and some silicate of soda formed during the fusion.

The content of the filter 1 was digested with hydrochloric acid for solution, then evaporated to dryness to render silica insoluble, redigested in hydrochloric acid, diluted, filtered, and hot washed. The iron and alumina were in the filtrate, and the silica remained upon the filter, and was discarded. It is inadvisable to throw the filter and its contents together into the beaker; for, hot digestion with acid renders a portion of the organic matter of the paper soluble, and thus makes the subsequent precipitation of the iron imperfect. It is much better to remove the iron from the filter with a platinum spatula, and to displace the adhering traces with hydrochloric acid and hot water, as directed in a previous page. The paper filter would then be thrown away, as the washing with acid and water removes every trace of iron and alumina.

The filtered liquor was boiled in a silver capsule with a slight excess of caustic potassa solution, filtered, and washed with hot water. To remove the potassa obstinately retained by the iron on the filter, the latter was redissolved in hydrochloric acid, precipitated by aqua ammonia, filtered, thoroughly washed with hot water, and dried. The paper and contents were ignited separately and weighed.

The filtrate which contained the aluminate of potassa was supersaturated with hydrochloric acid, and then treated with carbonate of ammonia, which threw down alumina as well as the silicic acid that remained in the liquid as soluble silicate. After filtration, the two were separated by digestion in hydrochloric acid, and evaporated to dryness, which left the silica and dissolved the alumina. The latter was then precipitated from the filtered solution by carbonate of ammonia, dried, ignited, and weighed.

Now even at this stage of the process, there is a serious objection; in the first place, during the fusion with carbonate of soda a portion of the iron as well as of the alumina will inevitably unite with some of the silica to form a slag insoluble by subsequent digestion in acid, thus giving rise to an error in the estimation of both these ingredients. Moreover, the boiling with carbonate of soda may have caused the solution of traces of free alumina as well as of phosphate, either of which is partially soluble in a dense solution of carbonate of soda. These being passed into the phosphate filter serve to contaminate it.

The contents of the filter 1 having been estimated, the filtrate 2 containing phosphate and silicate of soda with excess of carbonate of soda, was neutralized with hydrochloric acid to remove carbonate of soda, and then treated with a given weight of fine iron wire dissolved in nitric acid. The phosphoric acid was then precipitated with the iron by caustic ammonia, redigested in hydrochloric acid, and evaporated to dryness to remove any silica that may have fallen with the phosphate and oxide of iron, and the latter was then reprecipitated from the filtered solution with aqua ammonia.

The evaporation to dryness, as above directed, was very necessary, as

some silica invariably goes down, but the quantity is in proportion to the density of the solution; the more dilute, the less is the quantity of silica which precipitates. The evaporation of the iron solution with hydrochloric acid endangers the volatilization of the phosphoric acid, and prolongs the process; and we therefore endeavored to provide against these drawbacks, by igniting the mixed precipitates of phosphate and oxide of iron and silica, weighing, redigesting the calx in hydrochloric acid, filtering, washing with hot water, drying, and igniting the insoluble residue, and estimating the oxide of iron and phosphoric acid by loss. But there was almost invariably a fusion of a portion of the iron and silex into insoluble slag, and a serious loss thus occasioned. Rose proposes (*Chem. Gaz.*, viii. 20,) to precipitate the silicic acid from the filtrate containing the soluble matters of the fluxed iron, alumina, &c., directly by carbonate of ammonia. We do not think that this gives a reliable result, for even if the solution were very dense, the precipitated silex would be in a gelatinous state, and consequently soluble in the water used for washing. Therefore, when the filtrate, after neutralization by hydrochloric acid, is treated according to Rose's directions, with sulphate of magnesia to precipitate triple phosphate, a portion of silica goes down with it. This fact was ascertained by digesting the ignited ammonia-phosphate of magnesia in hydrochloric acid, which left in every essay an insoluble residue of silicic acid. It was also observed, that during this digestion a part of the phosphoric acid was volatilized, as free magnesia existed in the solution.

We sought to obviate these difficulties by evaporating the phosphate filtrates to dryness, before neutralizing the excess of carbonate of soda with hydrochloric acid; but we found it impossible to render all the silica insoluble in this way, although it prevented the volatilization of the phosphoric acid. We therefore neutralized the filtrate in its *dilute* state with hydrochloric acid, added a nitric of solution of a given weight of fine iron wire, and proceeded as already mentioned on the preceding page, and with the same unsatisfactory results.

Rose was the first to note that phosphoric acid was volatilized from acid solutions of phosphates by heat, and the confirmation of the fact by ourselves was soon after reaffirmed by some conclusive experiments by Bunce, (*Silliman's Journal*, 1851,) which show the loss to vary from 8 to 50 per cent.

The process which we give in a former page is a slight modification of Otto's, and has the support of our experience in favor of its being the most reliable for these investigations. It differs favorably from others in permitting the entire separation of phosphoric acid from alumina, as well as other associates, and also in requiring fewer digestions with acid, and in prescribing a limitation of the temperature to 212° Fah., and thus of preventing as far as possible any loss of phosphoric acid by volatilization. The only inconvenience attending it is burning off a large amount of tartaric acid, and the separation of the alumina from the excess of magnesia added.

Fuchs has given a method, (Rose, ii. 438,) by which the silica, instead of reacting by fusion, is added to a hydrochloric solution of the oxide of iron, alumina, and phosphoric acid, in the state of liquid silicate of soda. Ulgren (*Jour. Prac. Chem.*, liii. 37,) amended it by substituting

a mixture of silicate of soda and sulphide of potassium, so that the iron may be precipitated as sulphide, the alumina as silicate, and the phosphoric acid remains in solution with the alkali. This is a very ingenious process, but is no less tedious than Rose's, and is moreover equally objectionable in other respects, from a liability of loss of phosphoric acid and alumina, owing to the repeated digestions required to isolate them from silica, &c. There is also a more recent method of the same chemist, (*Chem. Gaz.*, 1851,) based upon the permanent solubility of the ammonia-phosphate of magnesia in small quantities of ammoniacal solution of tartrate of iron, but not in ferridcyanide of potassium—tartaric acid and cyanide of potassium being the reagents employed. It may yield correct results, but it has no advantage over Otto's plan as to time and easiness of execution.

Reynoso's method of separating phosphoric acid by oxide of tin, (*Chem. Gaz.*, ix. 418,) appearing only to have been tried with an alkaline phosphate, we have not thought it necessary to devote the time required to determine its applicability to an aluminous compound, since we found Otto's plan all-sufficient for our purpose.

(To be continued.)

For the Journal of the Franklin Institute.

The Cunard Steamer Arabia.

The following communication has been called forth by the article in the Feb. number of the *Journal*, quoted from the *Artizan*. The greatest discrepancy between the two accounts is doubtless owing to the fact, that the breadth of beam given by the English Journal was measured on deck; while the other is taken at the load water line.

As some of the dimensions given in the last number of the *Journal*, as those of the *Arabia*, of the British and North American Royal Mail Steamship Co., are calculated to deceive your readers, I furnish you with the following, which are reliable:

Length of keel and fore rake,	285 feet.
Length on deck,	284 " 5 in.
Breadth of beam,	40 " 8 "
Depth of hold,	27 " 8 "
Length of engine space,	82 " 9 "
Tonnage—Hull,	2292·42
Engine space,	706·58

Cylinders, 104 inches in diameter, with a stroke of piston of about 9 ft. 6 or 8 in.

Draft of water at load line,	21 feet.

Boilers—Four return tubular, (836 brass tubes, 8 feet long, in each,) having 16 furnaces. Water wheels, 36 feet 10 inches in diameter, 28 arms, blades 9 feet 6 inches in length by 3 feet 6 inches in width.

Launching draft,	10 feet 5 in.
With machinery in,	15 "

By this statement of our correspondent, it appears that the proportion of breadth and length in the *Arabia*, is as 1 to 7; and the cylinder capacity is to that of the *Arctic*, or *Baltic*, as 80712 to 70880; tonnage (by United States measurement) 2268 to 2878, so that for the same *tonnage* the proportion of cylinder is 1·44 times greater in the *Cunard* steamer.

As our present law is of such a tenor that the registered tonnage

affords no indication of the real capacity of a vessel, it is necessary in comparing the Collins steamers with the *Arabia*, to remember that the depth of the former is 32 feet, while that of the *Arabia* is 27 feet 8 inches; so that the disproportion is even greater than above stated.

Steamboats in the Western Waters.

The following article from an esteemed correspondent will be read with attention. We are not aware that any previous attempts have been made to obtain correct indications of the power developed in the high pressure engines running on the Mississippi. The cards given by Mr. Gilman will therefore be interesting for their novelty, as well as from the high pressure of steam indicated.

One circumstance will be remarked as peculiar. We allude to the small variation existing between the pressure of steam in the boilers and cylinder, which two pressures are, in some of the cards, identical. In low pressure engines the application of an indicator has always shown a difference between these two, of from 1 to 3 pounds per square inch, with wide throttles, and with the shortest steam pipes; a difference exists even between the pressure in the cylinder and in the valve chest, when the piston is in motion; as it is obvious that there must always be *some* variation, (to produce any tendency to motion) and that such variation should be greater, the longer or smaller the pipe, and the greater the velocity of the piston, we think Mr. Gilman should state, for the satisfaction of his readers, where the steam gauge was attached,—what description of gauge was used, and whether it has been verified by the indicator. We make this remark, because the importance of the subject demands great care and accuracy in conducting experiments bearing upon it. Of the numerous cards sent, we publish those specified by Mr. G., as giving average indications of the performance of the engine under different pressures, &c. Among those not so specified, are several in which the exhaust curve passes below the horizontal line struck by the indicator pencil, which is usually called the atmospheric line, and is so called in the engravings; of these No. 7 is the most marked specimen. Can any of our correspondents explain the anomaly of a vacuum indication by a high pressure engine exhausting through a heater into the atmosphere?

COM. PUB.

For the Journal of the Franklin Institute.

To the Committee on Publications.

GENTLEMEN:—The delay in procuring an instrument with a range of pressure sufficiently high for a Mississippi steamer, has prevented me until now from sending you any indicator diagrams, in support of the assertions which I made in the September No. of the *Journal*. The instrument by which the accompanying diagrams were taken, was made by Stillman, Allen & Co.; the steam gauges, of which there were two, by which the boiler pressure was noted, were Borden's, of New Orleans; and readjusted for the occasion by the manufacturers.

The *Magnolia* is one of the best class of steam boats on the western rivers, and the only one described in "McAlpine's report," which is now

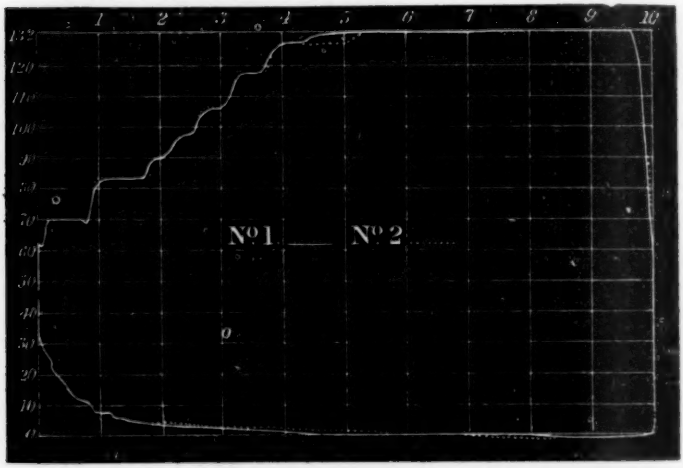
running on the lower Mississippi, and to which I have access; but as several of the engines in the boats referred to by Mr. Merrick, were constructed by the same engineer that constructed the *Magnolia's*, it may, in the absence of contrary evidence, be presumed that their proportions are equally as good. The engines of the *Magnolia* were built in 1845, and have been in constant use since that time, with the exception of a short period while changing them from the old to the new boat; the dimensions of the valves, steam ports and pipes, have not been changed since the engines were built; the valves are "double poppet," but not balanced; the main valve having a circular orifice in its centre, three inches in diameter, to which is fitted another valve, which rises three-eighths of an inch before the main valve commences to open; the upper and smaller valve, opening first, fills the port and clearance space, and thus equalizes the pressure on both sides of the main valve before it commences to open; the effect in the labor of the valve gearing is quite as favorable as that produced by the "balance poppet valve," the area of the small valve being about equal to the difference between the two that compose the "balance poppet;" and the effect upon the movement of the steam is sufficiently indicated by the diagrams; the valves are worked by cams, which give them their entire movement during one-eighth of a revolution of the main shaft; the cams being of such a shape as to preclude the possibility of their filling their yokes in all parts of their revolutions, the yoke sometimes is carried ahead of the cam by the weight of the valve lever, and thus produces the slight variation in the point of cutting off observable in the diagrams.

The engines are entirely disconnected; to which feature, with the great length of connecting rod and light construction of the boat, rendering it as supple as a long plank, may be attributed the irregularity of the expansion line, which, it will be observed, increases with the pressure of steam. Each engine has a separate steam and escape pipe and heater; the heaters consist of a cylinder, fitted with plates, lying in a plane horizontal in its diameter, and from three to five inches apart; and filling the cylinder in their width; but each alternate end detached from the cylinder by a space equal in area to the escape pipe, and slightly increased downwards. The cold water is thrown on to the top, and has to pass the entire length of each successively; while the exhaust steam, entering at the bottom, passes between and is brought into contact with each side of every plate successively, besides having to pass through as many sheets of water as there are plates in the cylinders; in general practice, this heater condenses nearly all of the steam, and supplies the boilers with water of the highest possible temperature; and with steam below the maximum pressure, exhaust the cylinder below the atmospheric line, as the diagrams attest.

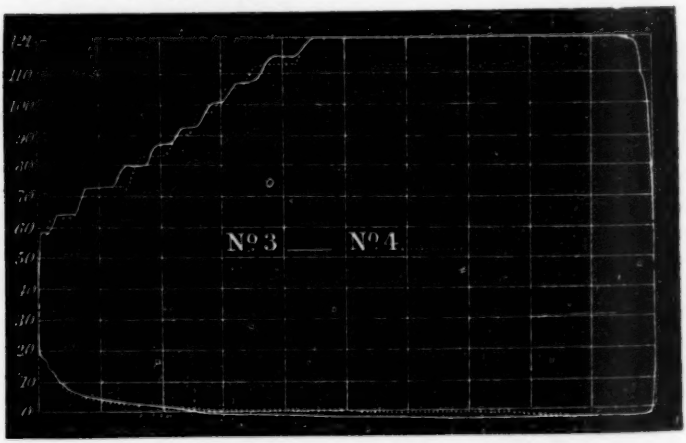
The fuel used in the *Magnolia* is, when running up stream, and in the cotton trade, yellow pine; and down stream, cotton wood, ash, and cyprus; when running down, in the Louisville and New Orleans produce trade, Pittsburg coal is used, with the yellow pine wood as bituminous coal; the boilers furnish an abundance of steam, at a pressure of 140 lbs. per square inch above the atmosphere; with a "wide throttle," and consuming seventy cords of pine wood every 24 hours; coal being sold here by measure, I have no means of knowing how much is consumed per day;

but allowing 40 lbs. per square feet of grate bar per hour, which is the maximum with a natural draft, 98·40 being the area of grate surface, $98{\cdot}40 \times 40 = 3936$ lbs. of coal per hour. The other descriptions of wood mentioned, furnished steam with a "wide throttle," of a pressure above the atmosphere of 120 lbs. and a consumption of eighty cords per 24 hours.

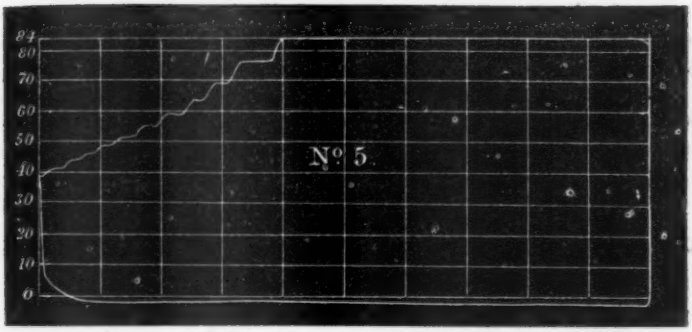
INDICATOR DIAGRAMS.—Starboard engine, February 2d, 1853.



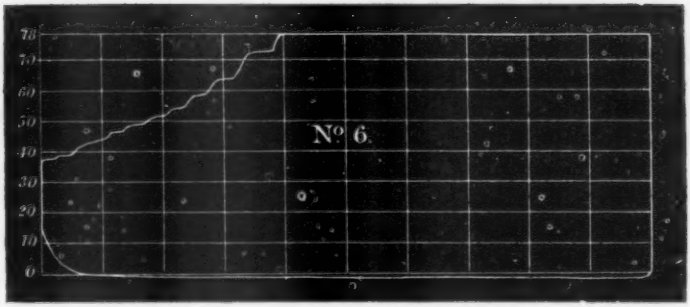
	No. 1.	No. 2.
Revolutions per minute, . . .	13·5	13·5
Portion of stroke during which steam was admitted,	·6	·6
Mean effective pressure on piston, . . .	112·28	111·94
Horses power developed by one engine, .	615·48	613·80
Pressure of steam in boiler, . . .	132 lbs.	132 lbs.



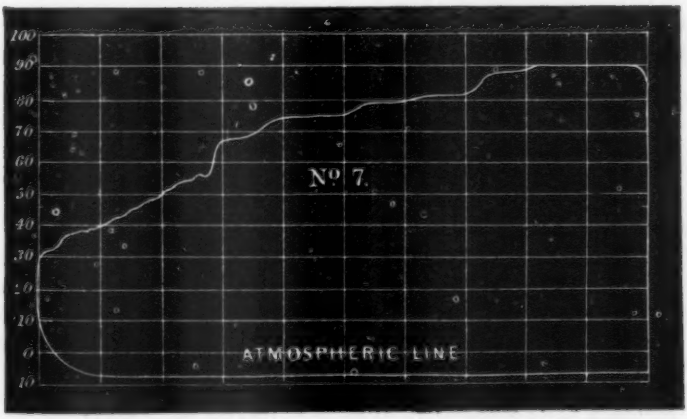
No. 3. Boiler pressure 121 lbs. Full throttle.
" 4. " " 120 lbs. " "



No. 5. Boiler pressure 84 lbs. Full throttle.



No. 6. Boiler pressure 78 lbs. Full throttle.



No. 7. Boiler pressure 120 lbs. Throttle open ½-inch; revolutions (not given.)

These diagrams were taken during an "up trip," and with yellow pine for fuel; Nos. 1 and 2, are the average of about 100, taken during 400

miles travel; Nos. 3, 4, 5, 6, were taken when about to stop, and the boiler pressure reduced; the others were taken to show the effect of throttling. Taking Nos. 1 and 2 for the mean efficiency of the boilers, the following will be the economical efficiency of the fuel. The cubic contents of both cylinders, clearances, and ports, up to the point of cutting off for one revolution, are $(127{\cdot}428 \times 13{\cdot}5 \times 60) = 103216{\cdot}68$ cubic feet of steam per hour of a pressure of 132 lbs. per square inch above the atmosphere; the corresponding volume being 211; therefore $103216{\cdot}68 \div 211 \times 62{\cdot}5 = 30570{\cdot}68$ lbs. of water evaporated per hour by $\left(\frac{70}{24}\right) = 2{\cdot}916$ cords of wood; $\frac{30570{\cdot}68}{2{\cdot}916} = 10483{\cdot}77$ lbs. of water evaporated by one cord of wood; allowing the wood to be of the best description of yellow pine, weighing 2700 lbs. per cord; then $\frac{10483{\cdot}77}{2700} = 3{\cdot}88$ lbs. of water evaporated by one lb. of wood; and if the relative value of the best yellow pine and coal, is as two to one by weight, $3{\cdot}88 \times 2 = 7{\cdot}76$ lbs. of water are evaporated by one lb. of coal, in the *Magnolia's* boilers; which is corroborated in another manner; 40 lbs. being the maximum consumed on one square foot of grate bar per hour, $\frac{30570{\cdot}687}{98{\cdot}40 \times 40} = 7{\cdot}76$ lbs. of water evaporated by one lb. of coal; this is exclusive of the steam used by the pumping engine, and the loss by blowing off; it is customary to blow off about once an hour, the quantity being determined by the appearance of the water. I observed the time during which the "mud valve" was kept open, average 20 seconds, with the valve open exceeding the area of the pipe, which is 3 inches diameter, and 21 feet long; the pressure being equal to a column of water $(132 \times 2{\cdot}30) = 303{\cdot}6$ feet high; if the periods of blowing off equalled 20 seconds, once in every two hours, the loss would be $\left(\sqrt{2500 \times 303{\cdot}6} \div 21 \times \frac{13{\cdot}88}{3}\right) = 281$ feet per second in velocity; and $\left(\frac{281 \times 20 \times 84 \times {\cdot}036}{2}\right) = 8497$ lbs. of water of a temperature of 361° blown off per hour; (84 is the contents in inches of one foot of pipe, and ·036 lbs. the contents of 1 inch,) of which 212° were furnished by the feed, and $(361° - 212°) = 149°$ by the fuel. The initial cylinder pressure as shown by the diagrams, is 132 lbs. per square inch above the atmosphere, the total heat of which is 1212°, of which 212° are furnished by the feed; leaving 1000° to be furnished by the fuel. The proportion of water blown off to that evaporated, is 8497 to 30570·68, or five parts blown out and eighteen parts evaporated; therefore,

$$\begin{array}{r} 1000 \times 18 = 18000 \\ 149 \times \ 5 = \ \ 745 \\ \hline 18745° \end{array}$$

= total heat supplied by fuel; 745° being 3·973 per cent. and lost by blowing off,

there remains 96·028 per cent. of the fuel utilized; therefore the amount of water evaporated per hour is $\left(\frac{30570{\cdot}68\times100}{96{\cdot}028}=\right)31835{\cdot}17$ lbs.; and by one lb. of coal $\left(\frac{31835{\cdot}17}{98{\cdot}40\times40}=\right)8{\cdot}08$ lbs. of water, exclusive of the amount used by the pumping engine, which could not readily be determined.

DIMENSIONS AND PROPORTIONS.

Length from stem to stern,		295 feet.
Breadth of beam,		35 "
Breadth of floor,		28 "
Breadth outside of guards,		72 "
Depth of hold,		9 "
Draft when light,		4 "
Tonnage, carpenter's measurement,	914·4	
Capacity in bales of cotton,	4500	
Capacity in pound freight,		1000 tons.
Diameter of wheel when light,		40 feet.
Length of bucket,		12 " 6 in.
Width of bucket,		24 "
Revolutions per minute up stream,		13·5
Diameter of cylinders,		30 in.
Length of stroke,		10 feet.
Length of connecting rod,		35 "
Point of cutting off from the commencement of stroke,	·6	
Diameter of main steam valve,		8½ in.
" " upper steam valve,		3 "
" " exhaust valve,		10 "
" " each steam pipe,		8½ "
" " exhaust pipe,		12 "
Number of boilers,	6	
Length of each boiler,		30 feet.
Diameter of each boiler,		42 in.
" " flue,		16 "
Superficial area of grate bar,		98·40
Diameter of each chimney,		5 feet.
Height of each chimney above grate bar,		80 "
Area over each bridge wall in square feet,		42·776
Area of the cross section of all flues in square feet,		16·75
" " " the two chimneys,		39·27
" heating surface of all the boilers,		2617·80
Proportion of grate bar to heating surface,		1 to 26·40
" " " area and bridge wall,		1 " 0·4753
" " " " of cross section of all flues,		1 " 0·1702
" " " " " " chimneys,		1 " 0·3986
Coal consumed per horse power per hour,		3·20 lbs.
Water evaporated by 1 foot of heating surface of boilers per hour,		11·29 "
" " " " grate bar per hour,		310.67 "
Horse power developed,		1229

SAMUEL H. GILMAN.

Baton Rouge, La., Feb. 24th, 1853.

For the Journal of the Franklin Institute.

The U. S. Steamship Saranac. By B. F. ISHERWOOD, Chief Eng., U. S. N.

The *Saranac* is one of the four steamships belonging to the United States Navy, commenced in 1847. The hull was built at Portsmouth,

New Hampshire; the machinery at Boston, by Coney & Co., from the plans of Charles W. Copeland, Esq. She left Portsmouth, N. H., on the 10th April, 1850, and made her first trip to Norfolk, Va. From that time I am in possession of the logs of all her steaming up to March 29, 1852.

The hull of the *Saranac* is of the same size, and is built of live oak from precisely the same lines, as the *San Jacinto*, a screw propeller steamer belonging to the U. S. Navy, and constructed at the same time as the *San Jacinto*.

HULL.—

Length of keel,	203 feet.
Length on load line,	210 "
Length between perpendiculars,	215 "
Length, extreme,	237 "
Beam, moulded,	37 "
Beam, extreme,	38 "
Depth of hold,	23 " 6 ins.
Depth of keel and false keel,	1 " 3 "
Displacement of sea water, 1838 tons and 1658 lbs. at 15 ft. 3 in. draft of water.	
" " 1900 " 15 " 8 " "	
" " 2100 " 16 " 9 " "	
" " 2202 " and 2055 lbs. at 17 " 3 " "	
Immersed amidship section at 15 ft. 3 in. draft of water,	420·05 sq. feet.
" " 15 " 8 " "	438·56 "
" " 16 " 9 " "	477·05 "
" " 17 " "	486·55 "

The *Saranac* is barque-rigged, and spreads 12,800 square feet of canvass in the plain sails.

ENGINES.—Two inclined, direct acting, condensing engines, with inclined forcing air pumps. The cylinder valves are of the double poppet kind; the steam is cut off with the steam valves by Stevens' arrangement.

Diameter of cylinders,	60 in.
Stroke of pistons,	9 feet.
Space displacement of both pistons per stroke,	353·43 cub. feet.
Steam space between cut-off valves and pistons at one end of both cylinders,	16 "
Diameter of the disks of the steam and exhaust valves,	12¼ and 13¼ in's.

PADDLE WHEELS.—Of the common radial kind.

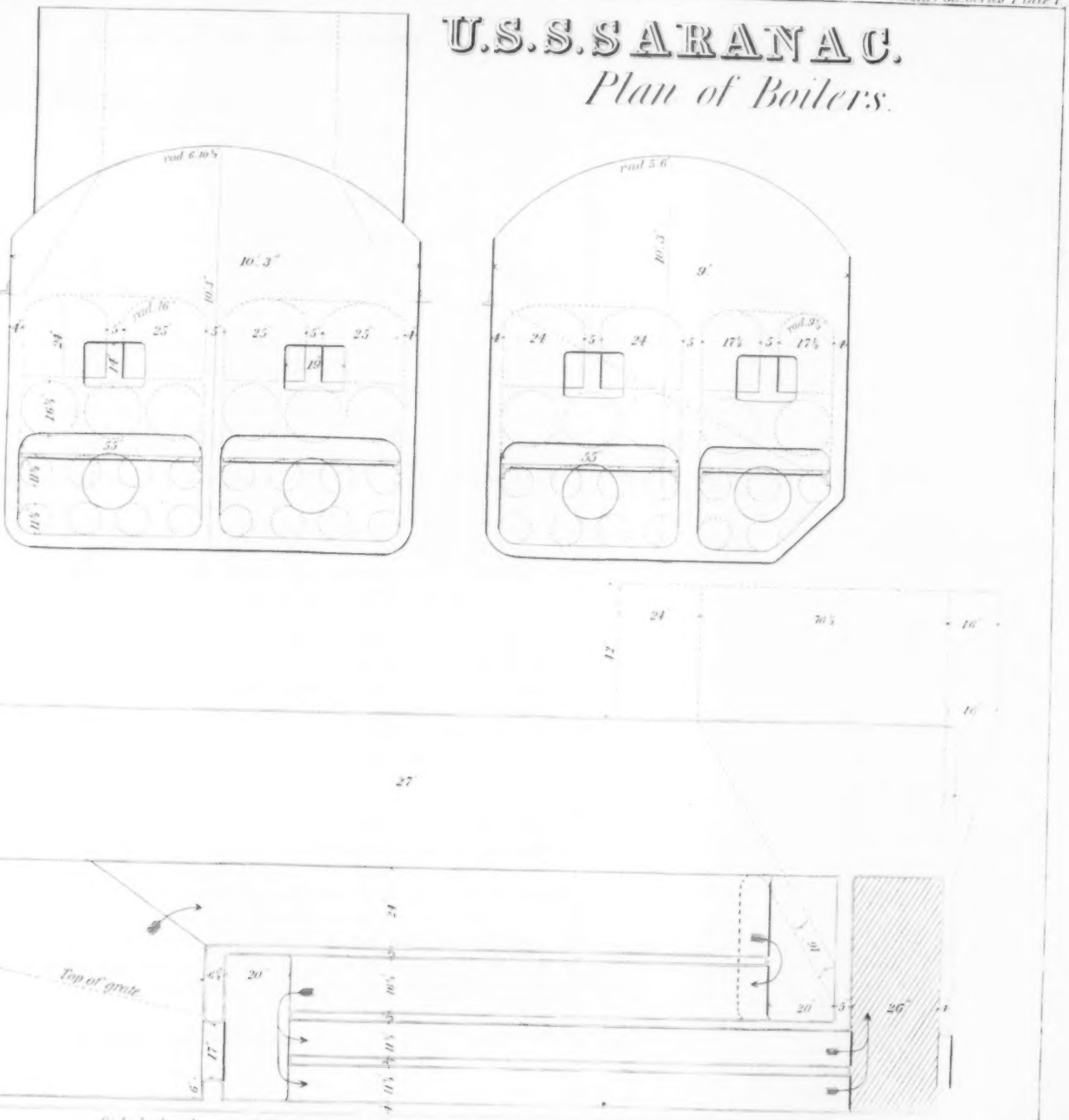
Diameter from outside to outside of paddles,	27 feet 6 inches.
Length of paddle,	9 "
Width of paddle,	30 "
Number of paddles in one wheel,	22.
" " in water in one wheel at 16 feet draft,	5.
Area of two paddles,	45 square feet.
Area of all immersed paddle surface at 16 feet draft,	225 "

BOILERS.—Three copper boilers, with double return drop flues. The boilers are placed side by side, with one smoke chimney in common.

Length of each boiler,	27 feet.
Breadth of the centre boiler,	10 " 3 inches.
Breadth of each side boiler,	9 "
Height of each boiler, exclusive of steam chimney,	10 " 3 "
Area of the total heating surface in the three boilers,	5127 square feet.
" " grate "	191¾ "
Aggregate cross area of the upper row of flues in the three boilers,	41·528 "
" " middle " "	23·758 "
" " two lower " "	30·295 "
Cross area of the smoke chimney,	31·919 "
Height of smoke chimney above the grates,	62 feet.
Capacity of steam room in the three boilers,	1750 cubic feet.
Weight of sea water contained in the three boilers,	83,600 pounds.

U.S.S. SARANAC.

Plan of Boilers.



State boiler shown in full lines alterations for middle boiler shown in dotted lines.

PROPORTIONS.

Proportion of heating to grate surface, . .	26·749 to	1·000
" grate surface to aggregate cross area of upper row of flues,	4·615	"
" " " to aggregate cross area of upper row of flues,	8·067	"
" " " to aggregate cross area of the two lower rows of flues,	6·327	"
" " " to cross area of smoke chimney,	6·005	"
Heating surface per cubic foot of space displacement of piston per stroke, ...	14·506	square feet.
Grate surface per cubic foot of space displacement of piston per stroke, ...	0·5423	"

Steam Log.—The steam log has been divided into two tables, the one giving the performance under steam and sail, the wind being chiefly abaft the beam; the other giving the performance under steam alone, the wind being chiefly forward the beam. The double stroke of piston, steam pressure, and point of cutting off may be depended on with absolute certainty, as the first was taken by counter, and the second, which rarely varied but a per centum in an hour, was determined from the mean of observations every fifteen minutes; the last was determined by the indicator. The two elements in the performance on which doubt may reasonably be supposed to exist are, the speed of the vessel, which was determined by the *chip log*, and the consumption of fuel, which was ascertained by measure, the average weight of a fixed measure being taken as the standard.

In the ordinary operation of a steamer, it cannot be known whether the amount of fuel logged opposite an hour, was actually burned in that hour, as the log only expresses the quantity of fuel actually put in the furnaces during that hour. As the means given in the tables, however, are usually for many hours, this source of error must, for the aggregate, be greatly reduced. And when the large number of observations are considered, which go to make up by their mean the final result, it is probable that result is a very close approximation to the truth.

In the steaming given in both tables under dates of April and May, 1850, it is certain the speed of the vessel was overlogged, as is manifest by a consideration of the slip, which was only between 4 and 5 per centum when steaming against a moderate breeze. In this case, the revolutions being by counter, the error must have been made in logging the vessel, as the slip could not have been less than about 16 per centum.

The evaporation in the *table of results*, is calculated from the number of cylinder charges of steam, and from Regnault's data for the total heat of steam of the different pressures. The agreement in the two cases is very close.

TABLE OF THE PERFORMANCE OF THE "SARANAC" UNDER STEAM ASSISTED BY SAIL.

DATE.	Number of consecutive hours.	Speed of the vessel per hour, in knots of 6085⅔ feet.	Course of the Vessel.	WIND. Direction.	WIND. Kind.	Sail.	Sea.	Mean draft of vessel. ft.	Mean draft of vessel. in.	Immersion of lower edge of paddles. ft.	Immersion of lower edge of paddles. in.	Slip of the centre of pressure of the paddles in per cents. of its speed.	ENGINES. Steam pressure in boiler per square inch above atmos.	ENGINES. Double strokes of piston per minute.	ENGINES. Steam cut off at from commencement of stroke.	ENGINES. Proportion of throttle open.	ENGINES. Back pressure in condenser per gauge.	Cumberland bituminous coal consumed per h'r.
								ft.	in.	ft.	in.		lbs.		ins.		lbs.	lbs.
Ap. 10, 11, 12. '50	19	10·487	——	On quarter.	Mod. breeze.	All sail.	Smooth.	15	10	4	5	4·64	7·0	13·713	48	3-16	1¼	1783
May 21.	24	11·500	S. ¾ W.	E. S. E. or abeam.	" "	Jib, foretopsail and spanker	"	16	0	4	7	6·58	11·4	15·350	42	7-16	1½	2725
May 24.	19	10·580	S. W.	S. E. or abeam.	Mod. wind.	Topgallant.	"	15	9	4	4	12·95	9·7	15·160	42	¼	2	2720
June 4 and 5.	7	9·000	S. by W½ W.	E. S. E. or abeam.	Strong wind.	{Fore topmast staysail, main trysail and spanker.	Ordinary.	16	2	4	9	4·89	8·3	11·800	42	3-16	2	1605
June 9 and 10.	42	8·882	N.	South or aft.	Mod. wind.	Topsails.	Smooth.	15	7	4	2	12·95	8·0	12·724	42	3-16	1½	2094
Jan. 27, 28, '51.	33	8·633	S. by E.	S. W. or for'd the beam.	" "	Fore and aft.	"	17	9	6	4	14·18	12·5	12·544	42	¼	1½	2140
Jan. 29.	14	7·500	S. by E.	" " "	Strong wind.	" "	Chopping sea.	17	7	6	2	17·96	13·5	11·400	42	⅛	1½	1843
March 6, 7, 8.	52	9·210	N. W.	E. or on quarter.	Mod. wind.	All sail.	Moderate sea.	15	9	4	4	3·83	9·9	11·942	54	5-16	2	1971
March 16, 17.	10	8·800	W. N. W.	" " "	" "	Topgallant.	Smooth.	15	9	4	4	12·88	10·0	12·596	60	⅛	2	2550
April 3..	12	9·500	N. W.	N. or for'ard the beam.	" "	" "	"	15	9	4	4	24·79	14·2	15·750	54	¼	2	3760
June 6.	24	8·830	N. W. ¾ N.	" " "	Gentle br'ze.	Topsails.	"	16	9	5	4	9·90	12·0	12·220	42	¼	2	2950
July 4.	24	9·292	N. N. E.	W. or abaft the beam.	Strong wind.	All sail.	"	15	4	4	1	12·88	14·0	13·300	54	⅛	2	3067
July 6.	20	9·100	N.	S. E. or on quarter.	Mod. wind.	" "	"	15	2	3	9	15·95	14·0	13·500	54	⅛	2	3200
August 29.	24	8·833	S. by W.	E. by N. or ab'ft the bm.	Strong bree.	Topgallants.	Heavy ahead.	17	2	5	9	10·45	13·0	12·300	54	5-16	2	2817
Oct. 7 and 8.	48	8·583	N. W.	N. E. or abeam.	Strong wind.	Topsails.	Heavy sea.	17	3	5	10	15·73	12·5	12·700	54	7-16	2	2523
December 26.	24	7·792	S.	S. E. or for'rd the beam.	Mod. wind.	" "	Smooth.	17	2	5	9	14·01	10·5	11·300	54	⅜	1½	1846
December 31.	24	8·417	S.	E. or abeam.	" "	All sail.	"	16	7	5	2	21·08	13·4	13·300	54	⅛	1½	2625
March 11, '52.	24	7·917	E.	W. or aft.	Strong wind	Studding sails set.	Moderate sea.	17	6	6	1	14·15	9·0	11·500	54	⅛	2	2217
March 14.	12	8·000	S. W.	N. E. or aft.	" "	" "	" "	17	1	5	8	0·24	9·0	10·400	54	⅛	2	2216
March 19, 20.	24	8·583	N. W.	S. W. or aft.	Mod. wind	" "	" "	16	6	5	1	17·67	10·5	13·000	54	¼	1½	3034
Mar. 27, 28, 29.	48	9·146	W.	E. or aft.	" "	All sail set.	Smooth.	15	9	4	4	15·52	9·1	13·500	54	¼	2	3260
Means.		8·985						16	5	5	0	12·61	10·9	12·822	50	·36	1·9	2525

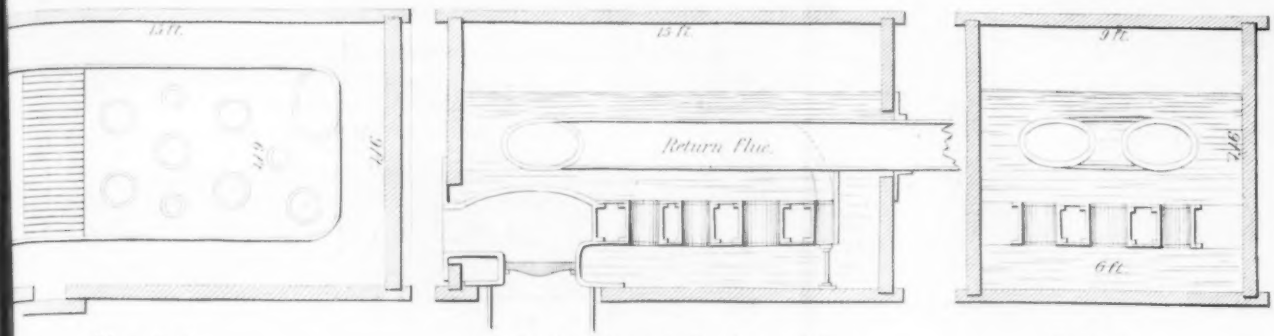
TABLE OF THE PERFORMANCE OF THE "SARANAC" UNDER STEAM ALONE UNASSISTED BY SAIL.

DATE.	Number of hours.	Speed of the vessel per hour, in knots of 6082⅝ feet.	Course of the vessel.	WIND. Direction.	WIND. Kind.	Sea.	Mean draft of vessel. ft.	Mean draft of vessel. in.	Immersion of lower edge of paddles. ft.	Immersion of lower edge of paddles. in.	Slip of the centre of pressure of the paddles in per cents. of its speed.	ENGINES. Steam pressure in boilers per square inch above atmos.	ENGINES. Double strokes of piston per minute.	ENGINES. Steam cut off at from commencement of stroke.	ENGINES. Proportion of throttle open.	Back pressure in condenser per gauge.	Cumberland bituminous coal consumed per hr.
							ft.	in.	ft.	in.		lbs.		ins.		lbs.	lbs.
April 10, 11, and 12, 1850.	40	11·027	S. by W.	On bow.	Mod. breeze.	Smooth.	15	10	4	5	4·66	6·9	13·115	48	1/4	1 1/16	1922
May 19 and 20,	29	11·531	N.	S. and E. or on bow.	"	"	16	2	4	9	4·14	11·3	15·000	42	5/8	1 1/16	2572
June 5, 6, 7, and 8.	65	6·049	N. E.	N. E. or on bow.	Strong wind.	Rough.	15	11	4	6	23·73	9·8	9·890	42	1/4	2 2 2	1917
October 15, 16, and 17.	31	9· 29	S. S. W.	N. E. or ahead.	Light breeze.	Smooth.	15	4	3	11	22·26	13·2	14·644	42	1/4	2 2 2	3147
December 4 and 5.	25	7·644	S.	S. or ahead.	"	"	17	3	5	10	10·60	11·6	10·662	42	1/6	2 2 2	1880
January 27, 1851.	15	7·793	S.	S. or ahead.	Mod. wind.	"	17	9	6	4	9·45	11·1	10·734	42	1/3	1 1/16	1892
Jan. 29, 30, 31, and Feb. 1.	74	7·486	E.	S. E. or on quarter.	Strong wind.	Rolling and chopping sea.	17	5	6	0	17·14	12·6	11·265	42	1/2	1 1/16	2146
Feb. 12, 13, 14, and 15.	84	6·740	N. W.	E. or ahead.	"	Heavy head sea.	15	10	4	5	29·42	8·5	11·933	54	·6	1 1/16	2450
March 15 and 16.	20	8·750	"	N. W. or ahead.	Mod. wind.	Smooth.	15	8	4	3	13·14	10·0	12·562	60	5/8	1 1/16	2410
March 17, 18, and 19.	46	8·626	N. N. W.	" "	Strong wind.	Moderate.	15	5	4	0	22·46	12·7	13·872	60	3/4	1 1/16	3772
April 4 and 5.	44	9·254	S. E.	W. or for'ard the beam.	Light breeze.	Smooth.	15	7	4	2	26·41	12·0	15·678	60	1/4	1 1/16	4386
May 18, 19, 20, and 21.	70	6·144	N. W.	S. and E. or ahead.	Strong wind.	Rough.	17	5	6	0	30·67	13·5	11·051	42	1/4	1 1/16	2428
June 7 and 8.	44	7·955	S. E ½ S.	N. or forward the beam.	Mod. wind.	Moderate.	16	6	5	1	27·23	13·0	13·631	42	·4	1 1/16	3294
June 29 and 30.	48	6·585	E.	S. and E. or ahead.	Strong wind.	"	17	3	5	10	22·93	12·8	10·655	42	1/2	1 1/16	2515
July 1 and 2.	48	7·319	N.	E. or ahead.	Fresh breeze.	"	15	10	4	5	22·90	14·3	11·850	54	1/4	1 1/16	2856
July 3.	24	8·383	N. N. E.	E. by S. or abaft the bm.	Light breeze.	Smooth.	15	8	4	3	22·97	13·9	13·900	54	1/4	1 1/16	3075
July 5.	24	7·875	S.	N. E. or ahead.	"	"	15	4	3	11	23·88	14·0	12·900	54	3/8	1 1/16	3054
August 30 and 31.	48	7·208	S. W.	S. or ahead.	Strong bree.	Heavy head sea.	16	11	5	6	19·39	13·5	11·150	54	1/2	1 1/16	2446
September 1, 2, and 3.	68	8·471	N. W.	S. W. or ahead.	Light breeze.	Smooth.	16	8	5	3	21·56	13·5	13·466	54	1/2	1 1/16	2859
October 6.	12	8·167	S. by E.	N. E. or abeam.	"	"	16	11	5	6	24·00	14·0	13·400	54	1/2	1 1/16	2325
December 25.	24	7·000	S. E.	S. E. or for'rd the beam.	Mod. breeze.	Moderate.	16	10	5	5	20·65	9·8	11·000	54	1/2	2 2 2	2030
December 28, 29, and 30.	72	7·431		E. or forward the beam.	Light breeze.	Smooth.	16	4	4	11	11·47	12·3	10·467	54	1/2	2 2 2	2143
January 24, 1852.	24	6·750	E.	E. or ahead.	Fresh wind.	Heavy head sea.	17	2	5	9	19·84	11·0	10·500	54	1/2	2 2 2	1763
Jan. 30, 31, and Feb. 1.	72	4·986	N. E.	N. E. or ahead.	Strong wind.	"	16	9	5	4	36·77	11·6	9·833	54	1/2	2 2 2	2246
February 2 and 3.	48	5·938	"	" " "	Mod. wind.	Moderate.	16	6	5	1	36·17	10·8	11·600	54	1/2	2 2 2	2448
February 4 and 5.	48	6·313	"	" " "	Light breeze.	Smooth.	16	3	4	10	29·71	7·8	11·200	54	1/2	2 2 2	2100
Means,		7·405					16	5	5	0	21·84	11·6	11·814	50	·41	1·7	2540

TABLE OF THE RESULTS FROM THE LOG OF THE "SARANAC."

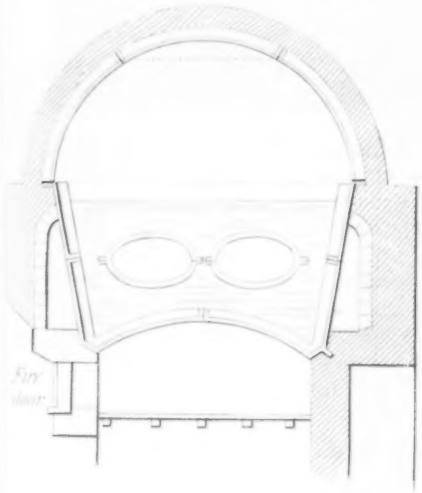
	Mean performance under steam assisted by sail.	Mean performance under steam alone unassisted by sail.	Mean of the total performance under steam assisted by sail, and under steam alone unassisted by sail.
OBSERVED.			
Total number of hours,	528	1·147	1675
Speed of the vessel per hour in knots of 6082½ ft.,	8·985	7·405	7·903
Mean draft of vessel in feet and inches,	16 5	16 5	16 5
Immersion of lower edge of paddle in feet,	5·	5·	5.
Steam pressure in boilers, in pounds per square inch above the atmosphere,	10·9	11·6	11.4
Steam pressure by indicator in cylinders, in pounds per square inch above the atmosphere,	7·9	9·1	8·7
Double strokes of piston made per minute,	12·822	11.814	12·132
Steam cut off at, from commencement of stroke of piston, in inches,	50·	50.	50·
Proportion of throttle open,	·36	·41	·39
Back pressure in condensers, in pounds per square inch,	1·9	1·7	1·8
Cumberland bituminous coal consumed per hour, in pounds,	2525	2540	2535
Cumberland bituminous coal consumed per 24 hours, in tons,	27·054	27.214	27·161
Area of immersed amidship section of hull in sq. ft.,	464·38	464·38	464.38
Displacement of hull in tons of sea water of 2240 pounds,	2038	2038	2038
CALCULATED.			
Mean effective steam pressure on pistons in pounds per square inch,	14·51	15·53	15.19
Horses power developed by the engines,	573·859	565.914	568.424
Slip of the centre of pressure of the paddles in per centums of their speed,	12·61	21·84	18·77
Loss of useful effect by the oblique action of the paddles in per centum of the total power applied to the paddles, calculated as the squares of the sines of their angles of incidence on the water,	16·65	16·65	16·65
Pounds of coal consumed per hour per square foot of grate surface,	13·173	13.253	13.226
Pounds of coal consumed per hour per square foot of heating surface,	0·492	0.495	0.494
Cubic feet of steam of atmospheric pressure furnished per minute, from sea water of twice the natural concentration, with temperature of feed water 100°F, including loss by blowing off to maintain twice the natural concentration, and loss of steam in the cylinders' nozzles, clearance, &c.,	7456·54	7531·34	7507·76
Pounds of steam evaporated per hour from one square foot of heating surface, from sea water of twice the natural concentration, with temperature of feed water 100° Fahr., including loss by blowing off to maintain twice the natural concentration, and loss of steam in the cylinders' nozzles, clearance, &c.,	3.208	3.240	3.230
Pounds of steam evaporated per hour by one pound of coal, from sea water of twice the natural concentration, with temperature of feed water 100° F, including loss by blowing off to maintain twice the natural concentration, and loss of steam in the cylinders' nozzles, clearance, &c.,	6·514	6.541	6·532

Boilers of the Philadelphia Water Works in 1801.

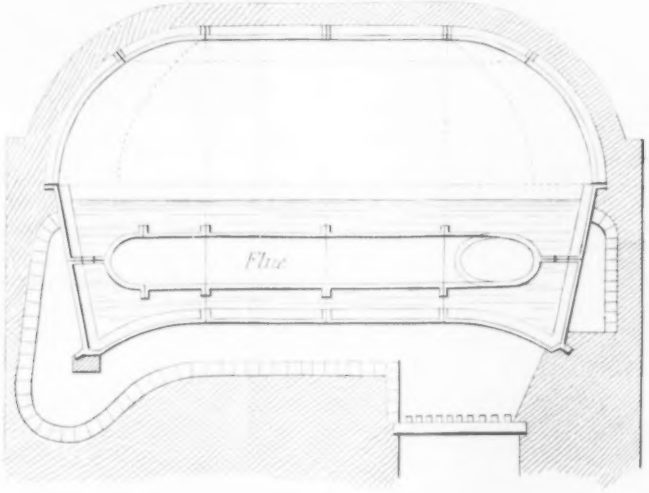


Plan Section. Section through fire box and flues. End Section.

End section of the cast iron boiler.



Section through centre of boiler.

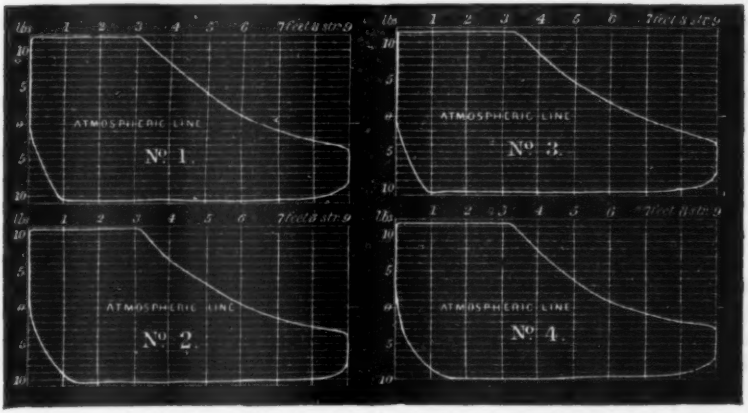


City of Philadelphia, and probably the first engines of such large dimensions manufactured in this country, may not be uninteresting to the readers of the *Journal*.

The first steam engine of any size appears to have been introduced into America about the year 1763, at the Schuyler copper mine, situated upon the river Passaic, New Jersey. All its principal parts were imported from England, and a Mr. Hornblower (the son it is believed of the well known steam engineer of that time) came to this country, for the purpose of putting up and running the engine.

Pounds of steam evaporated per square foot of heating surface, from sea water of twice the natural concentration, with temperature of feed water 100° Fahr., including loss by blowing off to maintain twice the natural concentration, and loss of steam in the cylinders' nozzles, clearance, &c., . . .	3.208	3.240	3.230
Pounds of steam evaporated per hour by one pound of coal, from sea water of twice the natural concentration, with temperature of feed water 100° F, including loss by blowing off to maintain twice the natural concentration, and loss of steam in the cylinders' nozzles, clearance, &c., .	6·514	6.541	6·532

Indicator Diagrams.—The appended diagrams are given to show the setting and condition of the valves. The leading feature, it will be observed, is a large degree of cushioning, caused by the closing of the exhaust valve before the completion of the stroke.



Nos. 1 and 2 are from the starboard and port cylinders; steam pressure in boilers per gauge, 13·25 pounds per square inch; back pressure in condenser per gauge, 1·7 pounds per square inch; double strokes of engine, 15 per minute; draft of vessel, 16 feet 1 inch forward, and 17 feet 1 inch aft. *Throttle wide.*

Nos. 3 and 4 are from the starboard and port cylinders; steam pressure in boilers per gauge, 14½ pounds per square inch; double strokes of engine, 15 per minute; draft of vessel, 16 feet 6 inches forward, and 17 feet 1 inch aft. *Throttle ⅗ths open.*

To be Continued.

For the Journal of the Franklin Institute.

Notice of the Earliest Steam Engines used in the United States. By Frederick Graff, Esq., Superintendent of Philadelphia Water Works.

(*With a Plate.*)

The following notice of the few steam engines used in this country in the year 1801, with a description of those erected and started in that year at the Centre Square and Schuylkill Water Works, believed to have been the first stationary engines of any considerable size put up in the City of Philadelphia, and probably the first engines of such large dimensions manufactured in this country, may not be uninteresting to the readers of the *Journal.*

The first steam engine of any size appears to have been introduced into America about the year 1763, at the Schuyler copper mine, situated upon the river Passaic, New Jersey. All its principal parts were imported from England, and a Mr. Hornblower (the son it is believed of the well known steam engineer of that time) came to this country, for the purpose of putting up and running the engine.

At the time when the manufacture of the engines for the Water Works was commenced, and as late as the year 1803, we find five engines, in addition to the one mentioned, noticed as being used in this country: two at the Philadelphia Water Works, one just about being started at the Manhattan Water Works, New York, one in Boston, one in Roosevelt's saw mill, New York, and a quite small one used by Oliver Evans to grind plaster of paris in Philadelphia.

The engines for the Philadelphia Water Works were manufactured by Nicholas Roosevelt, at works established by him near the copper mine above referred to, on the river Passaic. Their dimensions were as follows: that at Centre Square had a steam cylinder of thirty-two inches diameter, and six feet stroke, and worked a double acting pump eighteen inches diameter and six feet stroke, raising the water into a tank at the top of the building about fifty-one feet high.

The other engine, situated at the corner of Schuylkill Front and Chesnut streets, had a steam cylinder of forty inches diameter and six feet stroke, and a double acting forcing pump of seventeen and a half inches diameter and six feet stroke, raising the water about fifty-five feet. In both these engines, the lever beams, arms, and shafts of the fly wheels, the bearings upon which the fly wheels are supported, the hot wells, the hot and cold water pumps, the cold water cisterns, and even the steam boilers, were all of wood; in fact, all the engines mentioned above as then in use in America, were supplied with steam generated in wooden boilers.

The following is a description of those used at the Water Works. They were composed of rectangular chests, made of white pine plank, five inches in thickness, were nine feet square at the ends, and fifteen feet long, braced on the outside with oak scantling, and securely bolted together by rods passing through the plank. Inside the chest was a fire box with vertical flues, through which the water passed, the fire acting around them, and passing into an oval flue situated just above the fire box, and carried from the back to the front of the boiler and returned; this fire box was first made of wrought iron with the flues of cast iron, but the unequal contraction and expansion of the two metals caused continual leakage, and eventually wrought iron flues were substituted for those of cast iron. Mr. Latrobe, the engineer who designed the Water Works, claimed great merit for these boilers on account of the non-conducting power of the wood, and for the plan of the vertical flues contained in the fire box. He also gives the following memorandum of the work done by the engines: that at Schuylkill Front street pumping by actual experiment when running sixteen revolutions per minute 1,474,560 ale gallons per twenty-four hours, with a consumption of seventy bushels of Virginia coal; and the Centre Square engine pumping 962,520 ale gallons per twenty-four hours, consuming fifty-five bushels of coal; the pressure of steam ranging from two and a half to four pounds per square inch.

The wooden boilers first put in rotted out in seven years; those at Centre Square being renewed, were used as late as the year 1814. About the end of the year 1803, a new boiler, made totally of cast iron, was erected at the Schuylkill engine house. This boiler had semicircular ends, and was seventeen feet long, eight feet wide at the bottom, and nineteen

feet long, and ten feet wide, at near the top. The flame from the fire passed under the bottom, and around the back, into a flue which passed through the boiler and returned, and then around the outside of the boiler to the stack. This boiler was made of cast iron plates, with flanched joints, bolted upon the inside. The drawings of the wooden and iron boilers (Plate VII.) will explain more fully their construction.

The following extract from a Report made to the Watering Committee in July, 1801, by one of its members, who was sent to Roosevelt's manufactory to examine the progress making with the engines, and which describes the boring of the steam cylinder for the Schuylkill engine, gives a very good idea of the state of mechanical knowledge in this country at that time. The Report states that—

"The large cylinder is cast in two pieces and united by copper, the joint being secured externally by a strong iron band of cast iron, eighteen inches broad, and weighing twelve hundred pounds. Seven thousand five hundred pounds of iron was used to make the cylinder; it is six and a half feet long, and about thirty-eight and a half inches in the bore; about three-quarters of an inch was at first to be cut away. Two men are required; one almost lives in the cylinder, with a hammer in hand, to keep things in order and attend to the steelings; the other attends to the frame on which the cylinder rests, which is moved by suitable machinery; these hands are relieved. The work goes on day and night. One man is also employed to grind the steelings; the work only stands at dinner, and whilst the steelings are being changed, which requires about ten minutes time, and in ten minutes more are dull. I examined some, and found them worn an eighth of an inch in that time. Three steelings, which are about three and a half inches on the edge, are fixed in the head piece at one time; the head piece is a little less than the diameter of the cylinder, and six inches thick, secured on a rod of iron eight inches diameter, which forms the shaft of the water wheel. The workmen state that the boring was commenced on the 9th of April, and has been going on ever since, about three months, and that about six weeks more will be required to finish it."

"Eight or ten hands are employed on the fire box of the boiler; the wrought plates of which it is made are imported from England, are thirty-eight by thirty-two inches; that made in this country is clumsy stuff, of different sizes, the largest being thirty-six inches by eighteen."

This cylinder, after all the labor upon it, proved to be at least three-eighths of an inch larger diameter in the middle of its length, than it was at the ends. What a contrast does this present to the casting and boring done at the present day. I am informed that the cylinders for the Ericsson Caloric engine, eleven feet diameter, and about seven feet long, were bored complete by Messrs. I. P. Morris & Co., of this city, in something less than ten days time.

For the Journal of the Franklin Institute.

James Millholland's Improved Locomotive Boiler; Patented Feb. 17, 1852.

(*With a Plate.*)

Within the past few years, the attention of locomotive builders has been directed to the accomplishment of some plan for the economical and efficient combustion of anthracite coal in locomotive boilers.

Plate VIII. is an accurate engraving of Mr. Millholland's boiler as constructed for this purpose, and now in use on two passenger engines belonging to the Philada., Reading, and Pottsville Railroad Co. The main features of this boiler are, the use of "dust-plates," contracting the area of grate, and intended to prevent overheating on the sides of the fire box; and an intermediate, or mixing chamber, into which the flame and gases

resulting from combustion pass from the fire box between "water tables" or vertical water spaces, and from which (after mixing with cold air admitted through small holes) they pass through short tubes into the chimney. In connexion with this arrangement, it will be observed that there are two domes, one over the water tables, and the other over the tubes. From these domes steam is drawn to the engines in equal portions, by the use of a double beat or nearly balanced throttle valve, which seems decidedly preferable to the form of valve usually employed, and diminishes the effect of foaming when a high water level is carried.

The passenger engines above alluded to, have outside cylinders, 14 inches diameter, 2 feet 6 inches stroke; eight wheels:—7 feet drivers.

Dimensions of Boiler.—Length of fire-box, 5 feet 1 inch; thickness of bridge wall, 3½ inches; between bridge wall and front of water tables, 6 inches; length of water tables, 2 feet 6 inches; length of mixing chamber, 1 foot 9 inches; of tubes, 6 feet 6 inches; of smoke box, 2 feet 10½ inches; total, 19 feet 6 inches; diameter of shell, 4 feet; diameter of tubes, 1½ outside, 1·35 inches inside; number of tubes, 264; inner diameter of chimney, 1 foot 10½ inches; diameter of intermediate steam pipe, 3½ inches, of main connecting steam pipe, 5½ inches; height of water tables, 2 feet 8 inches; number of water tables, 9; grate, exclusive of dust plates, 2 feet 10 inches wide × 4 feet 3 inches long; area of grate, 12·12 square feet; nett area of grate between bars, 6·75 square feet; area for draft between water tables, 3·70 square feet; area for draft in tubes, 2·65 square feet; area for draft in chimney, 2·76 square feet; heating surface in fire-box, (over 1 foot above bars,) 55 square feet; in connexion up to water tables, 9 square feet; in water tables, 97 square feet; in mixing chamber, 15 sq. feet; in tubes (outside), 673 square feet; in two tube sheets, 11 square feet; total surface, 860 square feet.

Proportions.—Grate to heating surface, 1·00 to 70·95; grate to flue area between water tables, 3·27 to 1·00; grate to tubes area, 4.57 to 1·00; grate to chimney area, 4·37 to 1·00.

The following particulars of the performance of these engines, which have been in use on the regular traffic for some months, have been communicated by Mr. Millholland.

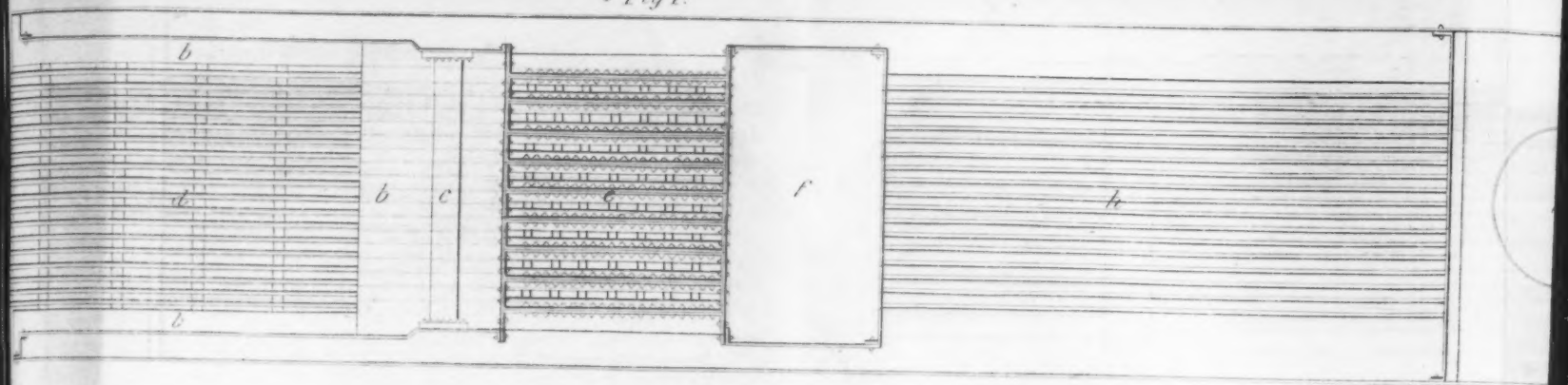
The engines run with trains, 93 miles, making 24 stops, and in addition, they run 3 miles without a train at Philadelphia end of the road; the engine house being located at Columbia Bridge, the engines to take or leave a train have to travel that distance; and at Pottsville, they have about the same distance to travel, making 93 miles with train, and 6 miles without train.

The amount of coal burnt on the round trip, (to Pottsville and back, as above,) is 4 tons, and 24 cubic feet of wood, which includes getting up steam. The amount of wood burnt by an ordinary passenger engine doing the same work, including getting up steam, is 6 cords.

The time required to get up steam from cold water is about 1 hour and 20 minutes.

The pressure of steam carried is about 100 lbs. per square inch, cut off (link motion) generally used at ½-stroke, but varied from ¼th to ¾ths during the trip; average length of time between Pottsville and Philadelphia,

Fig 1.



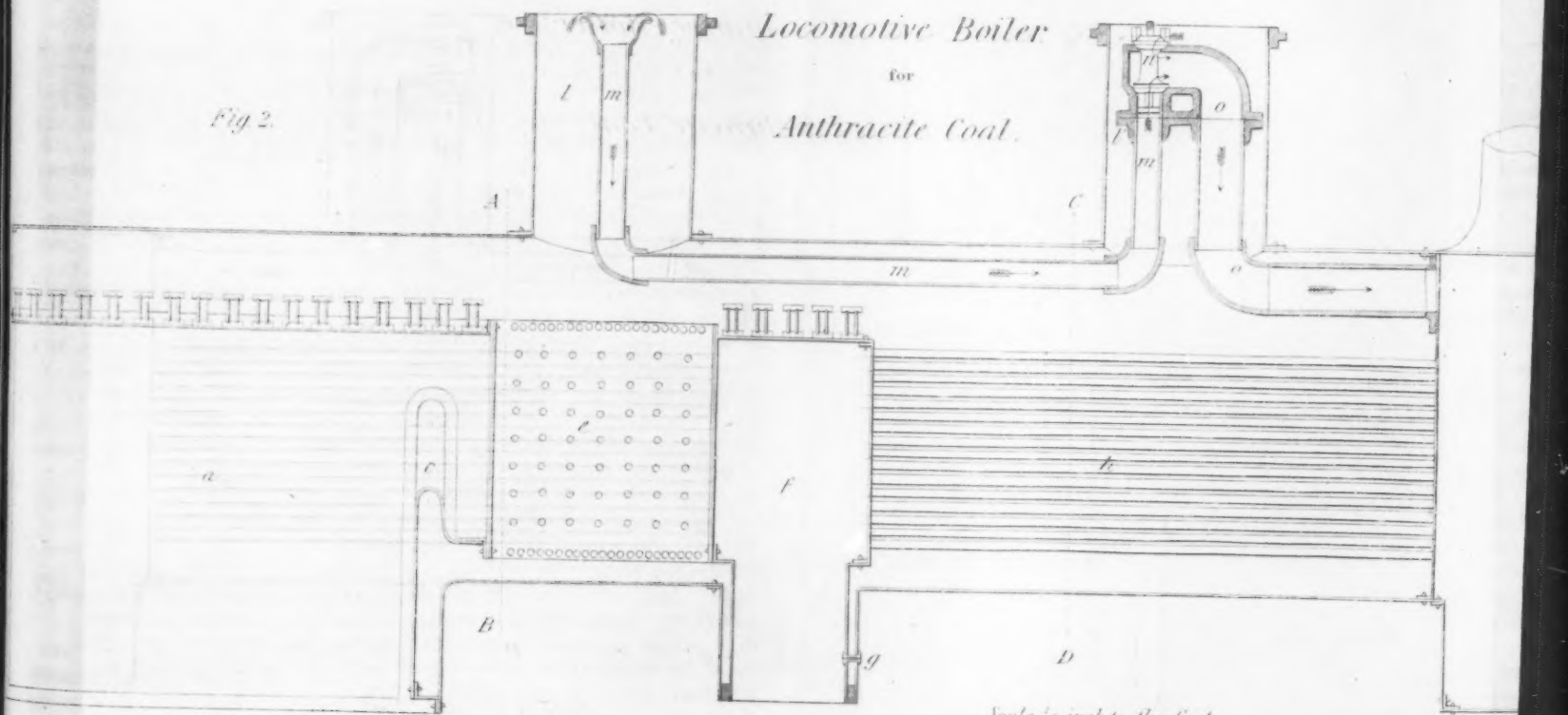
MILHOLLAND'S

Locomotive Boiler

for

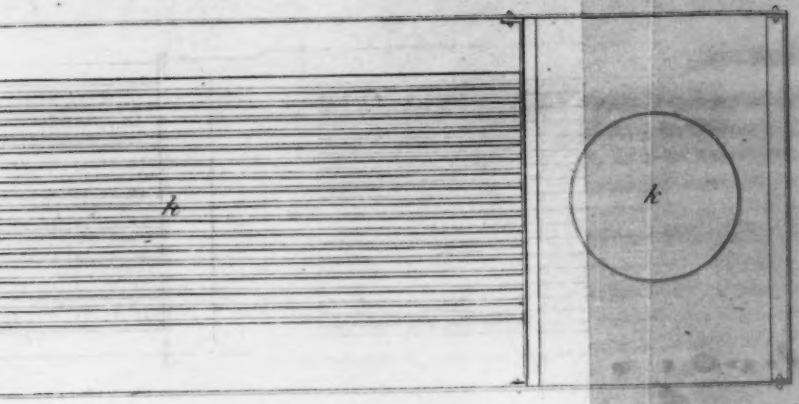
Anthracite Coal.

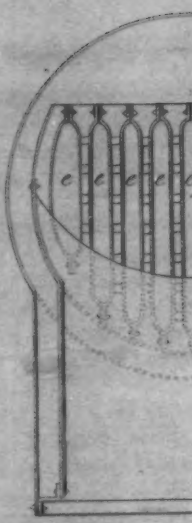
Fig 2.



Scale ½ inch to the Foot.

† From the London Mechanics' Magazine, November, 1852.

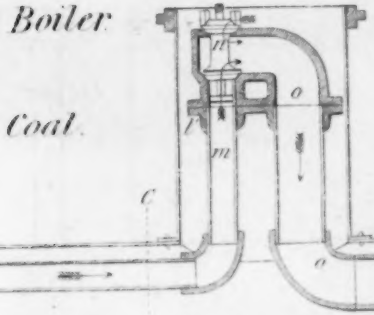




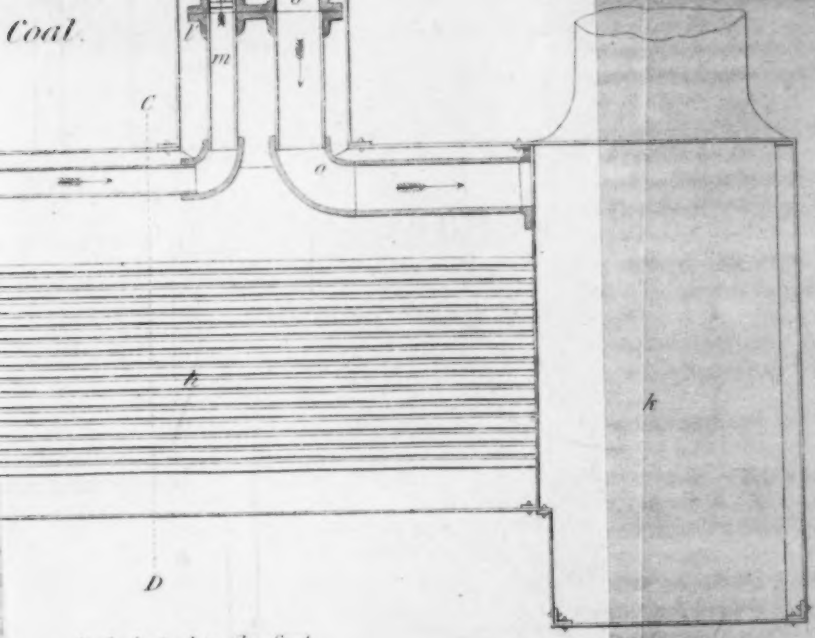
AND'S

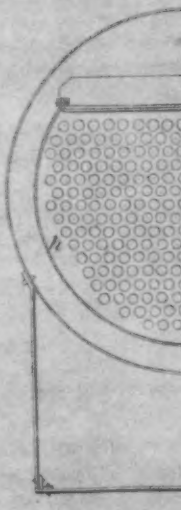
Boiler

Coal.



Fig





Scale ½ inch to the Foot.

Fig. 3.

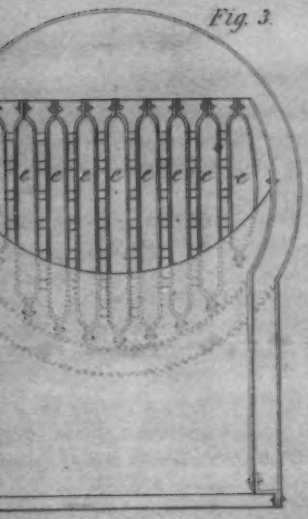
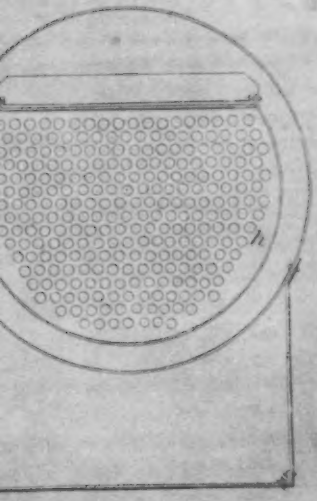


Fig 4.



(link motion) generally used at ½-stroke, but varied from [illegible] during the trip; average length of time between Pottsville and Philadelphia,

4 hours; the time is oftener less than more than four hours, which includes the time in stopping 24 times.

The drawing of this boiler was sent to England in either January or February of 1852.

DESCRIPTION OF PLATE VIII.

Fig. 1. Horizontal section through centre of boiler.
Fig. 2. Vertical " " "
Fig. 3. Vertical transverse section through line A B.
Fig. 4. Vertical " " " C D.
The same letters refer to similar parts in all the figures.

a, fire-box; *b*, *b*, *b*, dust plates; *c*, bridge wall, curved up at sides to give free passage for the steam formed within and below it; *d*, *d*, fire bars; *e*, *e*, water tables braced apart in the flue passages; *f*, mixing chamber for gases, &c.; *g*, 9 openings ¼-inch diameter through socket braces, for inlet of cold air; *h*, *h*, tubes; *k*, smoke box; *l*, l^1, steam domes; *m*, steam pipe to connect back dome to cylinders; *o*, steam pipe to connect both domes to cylinder; *n*, double beat throttle valve, regulating the engine, and opening passages to both domes.

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*First Decision under the New Steamboat Law.**

The inspectors of steamboats at Cincinnati, appointed under the new steamboat law passed by Congress, have made a thorough investigation into all the facts touching the recent collision on the Ohio, between the steamers *Falls City* and the *Pittsburg*. The testimony elicited established the following facts: The night was a foggy one when the collision occurred, and the "rules and regulations" requiring "ringing of the bells and blowing the whistle at intervals of two minutes, when running in a fog," were not complied with. Had they been complied with, the collision would not have taken place. As it was, laudable efforts were made by both boats, particularly the *Falls City*, to prevent it. The signal bell of the *Falls City* was tapped twice, signifying her wish to go to the larboard, and that of the *Pittsburg* tapped once, expressing a desire to go to the starboard, but, unfortunately, the signal of the one was not understood by the other. It was also proven that the collision would have been rendered less harmless had both boats instantly stopped on discovering each other. This was done by the *Falls City*, but not so promptly by the *Pittsburg*. In view of all the facts, they acquit the two engineers who were on duty at the time, and suspended for twenty days the license of John White, the pilot of the *Pittsburg*, and the license of Jeremiah Mason, the pilot of the *Falls City*, for ten days, for not observing the rules and regulations. The inspectors state that the penalty in this case is made light from the fact that the rules are new, and as yet imperfectly understood; but that in all future cases they shall exact the most rigorous penalties of the law.

New Patent Iron Cask.†

One of these casks arrived in Liverpool on Friday, from the works of Messrs. Fox, Henderson & Co., for the purpose of being tested here.

* From the North American and United States Gazette, March 9, 1853.
† From the London Mechanics' Magazine, November, 1852.

The dimensions of the cask are, 38 inches diameter of head, 43 inches diameter of bilge, and 42 inches length of stave. It was sent to the works of Mr. Thomas Croft, where it was filled with water, and found to contain 214 imperial gallons. An ordinary wood cask of ordinary dimensions would contain only 150 or 160 imperial gallons. When full it was rolled freely over flags and pavement, and found perfectly tight and strong. Afterwards it was lifted from the ground and suspended by ordinary can hooks fixed in the chime ends. It proved perfectly staunch throughout all the trials to which it was subjected.—*Liverpool Albion.*

For the Journal of the Franklin Institute.

Notes on the Trial Trip of the Steamer Carolina.

The particulars of this steamship having been given, p. 140, an account of her performance, on a trial made Feb. 21st, 1853, on the Delaware River, will be interesting.

Ship drawing about 9 ft. but slightly by the head; was laden with 347 tons of coal, water tanks, chains, anchors, a portion of sea stores, empty hogsheads, &c. Time, &c., made was as follows:

	H. M.	Time, Minutes.	Steam, pounds.	Vacuum, inches.	Rev. of engine.	Rev. of Propeller.	Throttle.	Remarks.	Distance in miles.
Passed N.Yard Shears	9 54½		13	26	29	72½		Wind strong ahead.	
" Point House,	10 9½	15	16	26	30½	76½		Tide flood & there-	2·12
" Fort Mifflin,	10 44	34½	17	26	31	77½		fore opposed.	6·13
									8·25
Returning,									
Passed Fort Mifflin,	11 9		32	26	34	85	} Partially	Wind in favor	
" Point House,	11 31½	22½	26	26	32	80	} shut off.	Tide " "	6·13
" Navy Yard,	11 41	9½	27	26	35	87½	Wide open.		2·12
									8·25

Her speed was therefore as follows, estimating tide current at 2 miles per hour; for the downward trip acting 50 minutes = 1·67 miles more than by shore marks, or whole distance run 8·25+1·67=9·92 miles; upward trip acting 32 minutes = 1·10 miles less than by shore marks, or distance run 8·25 — 1·10=7·15 miles.

Speed downward was therefore 9·92 miles in 49½ minutes = 12·03 miles per hour; average initial pressure of steam 15·65 lbs; vacuum 26 ins.; revolutions of engine, 30·3; of wheel, 75·7 per min.; slip, 8·27 per cent.

Speed upward, 7·15 miles in 32 minutes; or 13.09 miles per hour; average initial pressure of steam, (deduction made for wire drawing,) 22·00

pounds; vacuum 26 inches; revolutions of engine 33·5; of wheel 83·7 per minute; slip 9·76 per cent.

NOTE.—The above data of time, distance, revolutions, and pressure, from the source from which they are derived, are believed to be perfectly reliable; if so, they show a result in economical effect from the engine which it would probably be difficult to surpass.

M.

For the Journal of the Franklin Institute.

Particulars of the Steamer North Star.

New York.—This Steamer was built for Captain Cornelius Vanderbilt. Hull by J. Simonson; machinery, by Allaire Works. Intended service, New York to San Juan de Nicaragua.

HULL.—

Length on deck,	269 feet 6 ins.
Breadth of beam,	38 "
Depth of hold,	29 " 6 "
Length of engine and boiler space,	104 " 6 "
Draft of water,	14 "
Area of immersed midship section,	496·5 sq. feet.
Capacity of coal bunkers,	600 tons.
Draft of water at load line,	14 "
Floor timbers at throats, moulded,	1 " 6 "
" " sided,	10 "
Distance of frames apart,	2 "
Frames filled in solid,	4
Masts and Rig,	Brigantine.

ENGINES.—Two vertical beam.

Diameter of cylinders,	5 feet 6 ins.
Length of stroke,	10 "
Maximum revolutions, (expected,)	16, steam cut off at half stroke.
Weight of engines,	510,000 pounds.

BOILERS.—Four drop flued, with one tier of upper return flues in each.

Length of boilers,	23 feet. 11 ins.
Breadth "	11 "
Height "	10 " 6 "
" steam chimney,	12 "
Number of furnaces,	12
Length of grate bars,	7 " 2 "
Number of flues or tubes in one tier,	6
Internal diameter of flues,	1 " 3½ "
Heating surface,	4892 sq. feet.
Diameter of smoke pipes,	5 "
Height of smoke pipes,	36 "
Maximum pressure of steam,	20 lbs.
Weight of boilers, including smoke pipes,	176,000 "
Description of coal,	Anthracite.

WATER WHEELS.

Diameter,	33 "
Length of blades,	8 "
Depth of blades,	1 " 6 "
Number of blades,	28
Dip of wheels at the above draft,	7 " 9 "

Remarks.—The owner of this vessel intends to take passage in her so

soon as completed, and to visit the principal sea ports of Europe, and also those of the Mediterranean sea.

H.

AMERICAN PATENTS.

List of American Patents which issued from Feb. 15th, to March 1st, 1853, *(inclusive,) with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

FEBRUARY 15.

17. For an *Improved Adjustable Cut-off Gearing for Puppet Valve Engines;* Horatio Allen and D. G. Wells, City of New York.

Claim.—"What we claim are, 1st, The combination of pawls, with the two arms, whereby the valves are lifted and tripped, as described. 2d, The combination of the arms, provided with rollers, which in their action assist in transferring the pawls from one arm to the other, with the pawls and loose toes, as described. 3d, The making the rollers adjustable with reference to each other, by means of supporting them on independent arms, and connecting them to each other and the arms by means of a right and left screw, whereby the point of cut-off may be altered. 4th, The mode of operating the loose toes by means of pawls and rollers, substantially as herein described and represented. 5th, The mode of working the valves by hand, by means of toes supported on the rock shaft, substantially as herein described and represented."

18. For an *Improvement in Railroad Car Seats;* John Briggs, Boston, Massachusetts.

"The essential feature of my improvements consists in a curved sliding seat, upon which the back rests, which slides in or out, and can be fastened in any desired position."

Claim.—"Having thus described my improvements in car seats, what I claim as my invention is, a seat sliding in an arc formed in the frame work of the chair, and fastened in any desired position, as above set forth, whereby the back is made to follow the motion of the seat, in such manner as to preserve a constant or nearly constant connexion and angle therewith."

19. For an *Improvement in Machines for Manufacturing Harnesses for Looms;* Darius C. Brown, Lowell, Massachusetts.

Claim.—"What I claim as my invention is, 1st, The fliers constructed with a spring nose, or its equivalent, so as to yield the twine, when the needles draw the stitches into the rest, and to take up the binding twine, or draw it tight, when the stitches slip off of the needles. 2d, The apparatus or its equivalent for shoving the eyes off of the rod J', consisting of the cam, slide d^6, lever, rod d^5, and slide e. 3d, The revolving spring nose flier, or its equivalent, in combination with the needle, or its equivalent, for the purposes set forth, substantially as described."

20. For an *Improved Adjustable Heading Lever in Spike Machines;* Joshua C. Carey, Richmond, Virginia.

"The nature of my invention consists in sustaining the heading lever upon a movable fulcrum, so that it shall be capable of a nice adjustment, so as to throw the fulcrum of it to any point, inside or outside of a vertical line, drawn touching the plane of the face of the griping dies, or at a right angle to the spike rod, whereby the machine is enabled to bend the end of the rod up or down, or otherwise, according to the adjustment, and effect the heading of the spike in either direction, in one single motion upon its fulcrum."

Claim.—"Having thus fully described my invention, what I claim therein as new is, sustaining the heading lever upon a movable fulcrum, so as to be capable of adjustment to the requisite distance, inside or outside of a vertical line drawn touching the plane of the face of the griping dies, for effecting the heading of the spike, either up or down, or otherwise, in one single motion upon its fulcrum, substantially as in the manner herein set forth."

21. For an *Improvement in Paging Books;* Richard M. Leslie, Philadelphia, Penn'a.

Claim.—"What I claim as my invention is, 1st, The spring slat type wheels, made after the manner and operating for the purposes described. 2d, The combination and arrangement of the spring slat type wheels, the adjustable posts, sliding arms, spring

frame, inking rollers, with their tables, and the rod, with its ratchet and pawls, whereby I am enabled to number one side of four pages by single movement of the treadle, as above described and set forth."

22. For an *Improvement in Artificial Teeth;* Louis F. Sheppard, Alhambra, Illinois.

Claim.—"What I claim as my invention is, extending a suitable metallic plate over the masticating portion of artifical teeth, to protect them more effectually against injury from use, substantially as above described and set forth."

23. For an *Improved Saw Setting Machine;* Rand B. White, Meridian, New York.

Claim.—"Having described the construction and operation of my machine for setting saws, what I claim as my invention is, the combination of the spring hammer with the tooth gauge, both operating in the manner and for the purpose described as set forth."

24. For an *Improvement in Seed Planters;* David and Herman Wolf, Lebanon, Pa.

Claim.—"Having described the construction and operation of our invention and improvement, what we claim as new is, the movable clearer, arranged and operating in the manner and for the purpose herein set forth."

FEBRUARY 22.

25. For an *Improved Apparatus for Separating Ores or other Substances of different Specific Gravities;* Hezekiah Bradford and Elisha Fitzgerald, City of New York.

Claim.—"Having described the invention as it has been applied to the separation of copper ores, any competent machinist will be enabled to apply it to the separation of other substances of different specific gravity from each other. What we claim as our invention is, giving to the reciprocating pan, substantially such as above described, the peculiar motion above described, and by the means substantially as herein described. We also claim giving the back movement to the said pan in a less period of time than the forward movement, by means of a crank or cranks, whose axis of motion is below or above the plane of motion of the rear end of said pan, or by equivalent means, as described, and for the purpose specified. We also claim, in combination with a pan having the motion or either of the motions substantially such as specified, and on which the ore, &c., mixed in water, is supplied at some point towards the middle or back, the employment of a current or currents of water descending the inclined or curved surface of the said pan, in the manner and for the purpose substantially as specified. We also claim making the rear end of the said pan with an inclination or curve upwards, substantially as specified, and for the purpose set forth. We also claim making the said pan operated as specified, with apertures back of the place where the substances to be separated are applied, for the purpose and in the manner substantially as set forth. And, finally, we claim making the front and rear ends, or either, of the pan having a vibratory motion, with a gradual curve downwards, substantially as specified, when the same is employed in combination with currents of water, substantially as and for the purpose specified."

26. For an *Improvement in Gas Meters;* Alexander A. Croll, London, England.

Claim.—"What I claim as my invention is, the mode of arranging movable partitions or plates, so that the flexible material at the circumference of the plates shall not be bent but in one direction, substantially as set forth. And I also claim the arrangement and combination of the arms with the valves and movable plates of a dry meter, as set forth."

27. For an *Improvement in Sewing Machines;* William H. Johnson, Greenville, Assignor to William G. Bates, Westfield, Massachusetts.

Claim.—"Having described my invention, what I claim is, the making of the double loop stitch, having the loops upon one side of the cloth, by means of two needles, combined and operating substantially as herein fully described. I also claim the making a seam, or uniting two pieces of cloth, by means of the double loop stitch herein fully described, consisting of a plain stitch from a single thread on one side, and on the other, of a continuous chain formed of a succession of double loops from two threads."

28. For an *Improvement in Scythe Fastenings;* Alpheus Kimball, Fitchburg, Mass.

"My invention consists in an improvement upon a scythe fastening patented by E. S. Clapp."

Claim.—"What I claim as my invention is, the method of securing the blade of the scythe to the snath, by passing its shank through the end of the stationary metal cap, and securing it by means of the upward pressure of the screw, in combination with the claw and bush piece, constructed and operating in the manner substantially as described."

29. For *Improvements in Suspending, Lowering, and Liberating Ships' Boats;* Wm. S. Lacon, Great Yarmouth, England; patented in England, February 23, 1852.

Claim.—"Having now set forth my invention, and the manner of carrying the same into effect, I wish it to be understood that I do not confine myself to the precise arrangement of apparatus above described for carrying out my invention; but I claim suspending ships' boats, by having the chains or ropes so connected with drums or barrels, substantially as specified, that the two ends of the boat shall descend together, and with equal or nearly equal velocity, and so that the chains or ropes shall be free to disengage themselves from the barrels, in combination with the mode of controlling the turning of the barrels, by the weight of the boat, &c., substantially as specified."

30. For an *Improvement in Mortising Machines;* James Moreland, Adrian, Michigan.

Claim.—"Having fully described my improved apparatus, what I claim therein as new is, the combination of the cross bar on the cross head with the projecting dog on the movable way, for the purpose of withdrawing the chisel from the wood, on the back motion of the cross head, substantially as set forth."

31. For an *Improvement in Cut-off Motion for Looms;* Amos B. Taylor, Mystic, Connecticut, and Stephen Wilson, Jr., Westerly, Rhode Island.

Claim.—"We do not claim the roller against the warp, by which the position of the weight is regulated; neither do we claim the ratchet wheel and worm pinion, moved by a pawl or click from the lay, as these have before been used. What we desire to secure is, effecting and regulating the let-off motion by the variable counterpoise lever, in combination with the sliding worm pinion, when said worm pinion is acted on by the yarn beam, through a direct strain communicated to it by the tension of the warp; the whole arranged and combined in the manner specified."

32. For an *Improvement in Machines for Turning Irregular Forms;* Lauren Ward (Administrator of Richard Ward, deceased), Jerome B. Hubbell, and Hart C. Hubbell, Naugatuck, Connecticut.

Claim.—"We are aware that machines have been made for turning irregular shapes, by means of sliding centres, grooves, guides, patterns, cams, &c., and that cutters have been so formed and arranged as to assist the cams, &c., in giving the shape to the article; we therefore do not claim either of these, as such, as our invention: but what we claim as our invention is, the use of a cutter wheel for turning irregular forms, the cutters being so arranged that the pattern may be disclosed in reverse on its surface, when combined with the feed motion herein described, so that in turning said cutter wheel the desired irregular shape will be given to the article, without using guides or patterns, when the whole is constructed, arranged, combined, and made to operate, substantially as herein described."

Re-Issues for February, 1853.

1. For an *Improvement in Apparatus for Discharging Water from the Holds of Vessels;* Nehemiah Hodge, North Adams, Massachusetts; patented October 19, 1852; re-issued February 1, 1853.

Claim.—"I do not intend to confine my invention to the precise form or forms of its parts, as above described or as represented, but intend to vary the same, or any of the same, in any manner, while I do not change the principle or novel feature or character claimed as new, or as my said invention. I lay no claim to the invention of the system of "pendulum or swinging gutters," invented by M. Morel, and described in Belidor's Treatise on Hydraulics; nor the hydraulic machine of A. De Courdemoy, as described at page 205 of the first volume of Machines and Inventions approved by the Royal Academy of France, printed in 1735. But what I claim as my invention is, the combination of a system of two series of chambers, connecting pipes, discharging pipe, receiving hole or orifice, and ventilating pipes, as arranged, connected, applied to the hold of a navigable vessel, and made to operate during the rolling or pitching movements thereof, substantially in manner and for the purpose of elevating and discharging water therefrom, as herein above set forth."

2. For an *Improvement in Excluding Dust from Railroad Cars;* Edward Hamilton, Bridgeport, Connecticut, Assignor to Henry B. Goodyear, Administrator of Nelson Goodyear, deceased; patented May 27, 1851; re-issued February 15, 1853.

Claim.—"I do not wish to be understood as limiting myself to the mode of application herein specified, but to cover all modes which are substantially the same, and which operate on the same principle. What I claim as my invention is, inducing outward currents of air through the windows of railroad cars, to prevent the entrance of dust, &c., by

the action of the surrounding air on deflectors combined with the sides of the car, substantially as specified, and operating on the principle set forth."

DESIGNS FOR FEBRUARY, 1853.

1. For a *Parlor Stove;* James H. Conklin, City of New York, Assignor to William P. Cresson, Philadelphia, Pennsylvania; February 1; ante-dated December 13, 1852.

Claim.—"I do not claim the peculiar form of this stove, or any of the ornaments separately; but what I do claim is, the combination and arrangement of the ornamental forms and figures represented in the accompanying drawings, and forming together an ornamental design for a parlor stove."

2. For a *Sewing Bird;* Charles Waterman, Meriden, Conn., February 15.

Claim.—"What I claim is, the design herein represented by the feathered bird upon the wing, bearing a burden upon its back."

3. For a *Cradle;* Alexander Edmonds, Mount Pulaski, Illinois, February 22.

Claim.—"What I claim as my production is, the design and configuration of the ornaments above described and set forth, forming together an ornamental design for a horological cradle."

MARCH 1.

1. For an *Improvement in Bedstead Fastenings;* Asa N. & Alden Case, Gustavus, O.

Claim.—"We do not claim the pawl and ratchet as our invention; but what we do claim as new and our improvement is, the combination of the inclined plane, and head, with the pawl and ratchet, for the purpose of fastening bedsteads and tightening the cord, in the manner specified."

2. For an *Improvement in Swiveled Nibbed Keys for Door Locks;* Augustus C. Harig, Louisville, Kentucky.

Claim.—"I am aware that the nib of the key has been fitted into the tubular shank, and so secured therein by a pin fitting into a groove, that the burglar's instrument when applied to the nib would rotate it without moving the key, and in connexion therewith; I am also aware that the key, by a plate attached to the inner lock plate, has been held, so that it could not be rotated; and I therefore do not claim these devices. But what I do claim as of my invention is, the guard bit attached to the swivel nib, in combination with the ordinary bit and shank of the key, constructed and operating substantially as herein set forth."

3. For *Improvements in Rotary Steam Engines;* James McKay, Philadelphia, Pa.

Claim.—"What I claim as my invention is, the passages for the exhaust steam, arranged so that they shall cover and encircle the entire periphery of the stationary cylinder, and have their ingress and egress openings so arranged as to cause the exhaust steam, as it escapes, to envelop the whole surface of the cylinder, as described. In combination with the ordinary valves and parts which form a passage for the steam to and from the engine, I claim the supplemental exhaust parts and valves, which act in conjunction with the ordinary exhaust valves, whereby a free egress for the exhaust steam is afforded, without leaving large open passages for the steam to waste in. I also claim the combination of the sliding pistons with self-adjusting valves and steam ways, which admit a portion of the steam that propels the piston, behind its inner end, to act as a spring to press it out into the steam space, whichever way the engine may be turning. I also claim mounting or hanging the two cylinders on radial and axial journals, respectively arranged in a common plane, and at right angles to each other, whereby the two cylinders can accommodate themselves to each other, so as to avoid binding, substantially as herein set forth."

4. For an *Improved Machine for making Axes;* Jonas Simmons, Cohocs, New York.

Claim.—"I do not claim the employment of rolling dies for shaping an axe; but I claim the arrangement of the devices above mentioned for making axes, viz: rolling dies, with a rest bar to support the iron whilst being rolled, and an eye bar, arranged not only to serve as a mandrel to shape the eye of the axe, but with the rest bar to hold the iron firm during the process of rolling, the rest bar and eye bar being connected with the machinery to give them appropriate movements, to cause them to co-operate with the rolls in shaping the axe, and these parts further in combination with a scarfing bar, for the purpose of shaping the blade to receive the steel point, in order to complete the axe, substantially as the same is set forth in the within specification."

5. For an *Improved Supplemental Valve in Reciprocating Steam Engines;* Charles A. Spring, Kensington, Pennsylvania.

Claim.—"What I claim as my invention is, the arrangement of a valve in the lid of the steam chest, or the equivalent thereof, between the cylinder of a steam engine and the boiler, in such manner that it will prevent the reflux of the lead steam, by closing whenever the pressure of the steam in the engine exceeds that in the boiler, and opening again whenever the pressure in the boiler is greater, substantially as herein set forth."

6. For an *Improvement in Looms;* William Townshend, Hinsdale, Massachusetts.

Claim.—"I do not claim actuating the pickers by the backward motion of the lay alone; but what I do claim is, 1st, The cam wheel *l*, on the chain shaft 31, right angle lever *l'*, and staples or slide bolts 36 and 37, combined and acting as described and shown, to bring the picking motion into operation alternately on each side, by the backward motion of the lay, as specified. 2d, I claim actuating the picker staffs by the lay, on its backward motion, by means of the vibrating studs, when combined with levers 40 and 45, attached to the swords of the lay, and bent levers *m* and *m'*, the whole arranged and combined in the manner described. 3d, I claim the levers o^2 and o^3, connected together by the adjustable pin, so as to give greater or less motion to the selvage warp, when actuated by the cam *o*, as described and shown. 4th, I claim the apron or straps 62, connected to the bar *s*, and kept to the cloth by the proper weight or power, so as to cause sufficient friction to wind the cloth on the cloth beam, when said apron and bar are moved or actuated from the lay or otherwise, so as to produce the effects herein described and shown."

7. For an *Improvement in Bedstead Fastenings;* E. Sumner Taylor, Cleveland, Ohio.

Claim.—"I do not claim separately the pawl and ratchet, nor a continuous right and left hand thread or screw; but what I do claim as my improvement is, the combination of the pawl and ratchet with the spiral grooved sections attached to the tenons, arranged and applied in the manner and for the purpose herein specified, namely, the tenons of one side rail and one end rail being furnished with the plates having the spiral groove turning to the right and left as described, turning in the direction of the arrows, and making a tight joint with the post; the other side and end rails having on their tenons a groove, passing around the tenon at right angles to the axis, and fitting the pins as described, so that by having one side of the tenon on each end, flattened, to enable it to pass the pin, in order to allow it to enter the groove, when, by turning in either direction less than a complete revolution, the pin fitting into the groove prevents the posts and rails from separating; and by attaching the ratchets to the end of this side rail and one end of the end rail, with the pawls attached to the posts as specified, by tightening of the cord, put on in the manner described; the whole frame of the bedstead is held firmly together by the combined action of all the parts described, one end rail and one side rail remaining stationary, the other end rail and side rail turning as described, for the purpose of tightening the cord, both being secured by the pawl and ratchet."

8. For an *Improvement in the Construction of Curry Combs;* William Wheeler, Troy, New York.

Claim.—"What I claim as new is, the application of a ring, loop, or fixture on curry combs, for the insertion of a thumb as a guard and rest therefor, the ring or loop being made in one piece with the back strap, as set forth."

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, March 17, 1853.

Samuel V. Merrick, President, in the chair.
Thomas Fletcher, Vice President.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Donations to the Library were received from The Royal Astronomical Society, London; L. Lea, Esq., United States Commissioner of Indian

Affairs, Hon. David Dale Owen, United States Geologist, Hon. Joseph R. Chandler, United States Congress, and The Smithsonian Institution, Washington City, D. C.; Dr. W. T. G. Morton, and George C. Rand, Esq., Boston, Massachusetts; William J. McAlpine, Albany, New York; the American Institute, City of New York; The Young Men's Mercantile Library Association, Cincinnati, Ohio; and from Messrs. A. Hart, Solomon W. Roberts, Birkinbine & Trotter, A. B. Hutton, Dr. Thomas S. Kirkbride, Chas. E. Smith, Harvey Tuckett, and Dr. B. Howard Rand, Philadelphia.

Donations to the Cabinet from The Brooklyn Flint Glass Company, New York; Dr. L. Turnbull, and Edward Miller, Esq., Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of February.

The Board of Managers and Standing Committees reported their minutes.

The Actuary reported the organization of the Board of Managers, and the Standing Committees for the ensuing year, by the election of their chairmen and appointing the time for holding their stated meetings, as follows:

Managers,	Alan Wood,	Chairman,	2nd Wednesday	Evening.
Committees.				
On Meteorology,	Owen Evans,	do	1st Monday	do
" Library,	Wm. A. Rolin,	do	1st Tuesday	do
" Models,	John A. Wimer,	do	1st Thursday	do
" Exhibitions,	John E. Addicks,	do	do	do
" Minerals & Geol. Specimens,	J. C. Trautwine,	do	2d Monday	do
" Meetings,	Dr. B. H. Rand,	do	do	do
" Arts and Manufactures,	Prof. J. C. Booth,	do	2d Tuesday	do
" Science and the Arts,	Prof. J. C. Cresson,	do	2d Thursday	do

New candidates for membership in the Institute (3) were proposed, and the candidates (6) proposed at the last meeting were duly elected.

Dr. Rand, Chairman of the Committee on Meetings, exhibited and described Mr. James J. Clark's self-winding telegraph register.

In this instrument the moving power of the drum on which the paper is coiled, is a spring, instead of a weight, as in the ordinary register. This spring, which is coiled on the shaft of the drum, is maintained at a constant tension, by means of a galvanic battery attached to the apparatus; a break circuit wheel is connected with the drum; each time the circuit is completed an electro magnet fixed on the base of the instrument attracts its armature, which is attached to one end of a lever, at the other end of which is a pawl which moves a ratchet wheel forward one tooth. The motion of this rachet wheel is communicated to the shaft of the drum, upon which the spring is coiled. The whole is so adjusted that the spring shall thus be wound up as fast as it runs down in turning the drum, and a perfect uniformity in the motion of the latter is secured. The tension of the spring may be altered in a few moments, without interfering with the action of the instrument.

(A detailed description of this apparatus will be published in a future number.)

Dr. Rand also exhibited Billings and Ambrose's carriage axle. The axle is grooved near its outer end; into the groove two sliding plates having a

horizontally projecting tooth upon the outer end of each, and compressed in grooves in the outer end of the hub, are slipped. The teeth upon the end of these plates are confined in grooves cut spirally in the face of a cam plate, in such a way that by turning the said plate in one direction or the other, the said shifting plates are forced in or withdrawn, and so form the connexion between the hub and the axle. Over the end of the hub is a covering cap, through the centre of which is a hole for the insertion of a key into the aforesaid cam; so that while the end of the hub is covered, the simple rotating movement of this key locks or unlocks the wheel and the axle.

Frederick Graff, Esq., Superintendent of the Fairmount Water Works, presented a portion of the wooden boiler in use at the works, in Centre Square, from 1801 to 1814, and which supplied steam for a forty horse power engine, carrying four and a half pounds pressure to the square inch. (Mr. Graff's description of this boiler will be found on pages 269-70-71.)

G. W. Smith, Esq., suggested that some use might be made of the heat of the water discharged from the hot well of stationary condensing steam engines which at present runs to waste, by the introduction of a number of small thin tubes, into a box filled with this hot water; the atmosphere passing through these tubes would absorb much of the heat, and pass immediately into the closed ash pit, in a state suitable to facilitate combustion and economize the heated products; the expense of these tubes might preclude their adoption where fuel is cheap.

Mr. J. Vaughan Merrick admitted that some saving of fuel might be the result, but considered that as the difference in temperature between the water in the hot well and that of the atmosphere would not be great, so large an amount of surface would be required as to make it doubtful whether the first cost, or space required for such an apparatus, would be repaid. He alluded to the plan adopted by Prof. W. R. Johnson, in his experiments on coals, of compelling the air to pass through openings in the side walls of the boiler setting before reaching the grate, as being more feasible. In those experiments the air entered the grate at a temperature generally higher than 212°.

Mr. Smith also called the attention of the members to a drawing of a design for an ornamental stand pipe, by Messrs. Birkinbine & Trotter.

Dr. C. M. Wetherill called the attention of the members to a modification of Kemp's thermostat.

A full description of this instrument will be published in a future number of the *Journal*.

Dr. Turnbull exhibited to the meeting a specimen of *galmel* or silicate of zinc, presented to the Institute by Edward Miller, Esq., obtained from Saucon Valley, Lehigh County, Penn'a. The crystals were small, tinted of a yellow color, associated with a portion of carbonate of zinc. It is a valuable ore of zinc, and is employed in the manufacture of brass. It could be used for preparing the zinc paint by precipitation, as it is readily soluble in acids, when the silica gelatinizes, and can be separated. It contains about 60 per cent. of metallic zinc.

Dr. Turnbull also brought to the notice of the meeting a specimen of *magnetite*, or magnetic oxide of iron, from Lake Superior. The ore was of a very fine quality; lustre, metallic; color, iron black; crystals, octahedral, mixed with garnet, which combination is considered highly ad-

vantageous for the reduction of this variety of ore, granular ores often requiring no other flux.

Mr. Barlow exhibited a model of Mr. Parker's system for banding pulleys, as used for driving a circular saw. In this arrangement the power is communicated to the belt by friction between pulleys, instead of friction over the driving pulley as usual. On the driving shaft a large pulley is keyed; near the centre of this shaft is pivotted a frame, carrying at the other end a second pulley, smaller than the first, which approaches that of the driver as it is moved in the direction in which the power is exerted; between the circumference of these two the belt is compressed, and passing back around about one-fourth the periphery of the larger wheel, returns over the saw pulley, whose axis is as near as possible to that of the driver. By this arrangement the belt is tightened as the power is increased, and the space required is much less than by the common method, since the belt may be shortened to one-fourth the circumference of the driving pulley.

Geo. W. Smith, Esq., presented two dioptric fixed light apparatus for ship's lanterns, each cast in one piece of flint glass, at the Brooklyn Flint Glass Works, Long Island, New York. They are very economical, compared with the ground glass dioptric lanterns, and intercept less light, and might be advantageously used for many purposes, viz: for piers, signal stations, street lamps, &c. Mr. Smith reminded the meeting that a few years ago he had suggested a modification of the form of lens for fixed lights, viz: the substitution of the meniscus or concavo-convex form in section, in lieu of the ordinary plano-convex lens. The advantages he proposed thereby were, first, the more direct incidence of the light from the lamp on the glass, and the less loss by reflection; second, the less diameter, both above and below, of the aperture of the drum, which enables it to intercept a larger portion of the emitted sphere of light. A less number of catadioptric rings would be required, and those of a smaller diameter than usual. The meniscal drums were made at the same works in Brooklyn, and all the curves calculated there by one of the employees of the Company. Mr. Smith believed that they were the first constructed on this plan which he had suggested. They were presented by the Company through Mr. Gilliland.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on J. & J. Dilks' Improvement in a Gauge for indicating the height of Water in Steam Boilers.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, an "Improvement in a Gauge for indicating the height of water in steam boilers," invented by Messrs. J. & J. Dilks, of Philadelphia, Pennsylvania—REPORT:

That an instrument similar in principle to this was formerly presented to the Committee for examination, by Mr. Jos. Dilks, and was favorably reported on. As it was feared by many, however, that the form of instrument then shown would be unfavorably influenced by the pressure of the steam on its slides, the Messrs. Dilks have modified it, and offer it in its present form. As now constructed, the gauge consists of a plug of brass, which passes through the head of the boiler, to which it is attached by a

proper screw. The axis of the plug is hollow, and in it is fitted a cylindrical rod, which terminates exteriorly in an index hand, which traverses a dial, and is protected by a glass face, as may be seen by the drawing.

The inner end of the plug is ground flat and true, and is covered with a plate fixed upon the rod; this plate being carefully ground, acts as a slide to prevent the access of the steam to the hollow axis of the plug through which the rod passes. Beyond this circular slide, the rod carries a pinion, and beyond this its extremity rests in a bearing supported from the plug, against which a spiral spring wound around the rod also abuts, which by its pressure is intended to keep the slide always firmly against the surface of the plug. To the side of the plug, the arm of the float is attached by a pivot, and carries a toothed quadrant so placed that its teeth shall gear into the leaves of the pinion on the rod of the index. It will be easily seen that by this adjustment, when the water in the boiler, and consequently the float, sinks, the index hand, by means of its rod and pinion, and the toothed rack on the float arm, will be moved in one way; when the water rises, it will be moved in the opposite direction; and these changes are clearly indicated in the graduated dial. At one point of the circular slide, a deep notch is cut in its circumference, and this notch is so placed that when the water has sunk so far as to reach a dangerous level, the notch corresponds to a second orifice drilled through the plug, and terminating outside in a steam whistle. By this means the existence of danger will be notified to the engineer and all others whom it may concern.

The Committee regard the gauge of Messrs. Dilks as simple and efficient. Like the magnetic gauge of Mr. Faber, it indicates the level of the water by means of a float, and dispenses with the stuffing box, (which was the

former objection to this method of indicating,) and appeals at every moment to the eye of the engine man, without requiring any experiment, as with the gauge cock and the percussion gauge, to show the level of the water. It is easy of construction and cheap, and can be easily and speedily removed at any time, when the boiler is not in actual use, for examination, or repair if it should need it, although it does not seem liable to get out of order, since it may be placed at any desired height above the water level. It also possesses the advantage, that by a simple and obvious mechanism outside of the boiler, its indication of the water level may be transmitted to any place, and the manager of an establishment may thus have under his eye in his office the state of the water in all the boilers under his charge.

The recent improvement introduced by Messrs. Dilks in the application of their principle, will much diminish the liability to stick, if such existed in the original form, by diminishing the area of the surfaces in contact; and the Committee believe that the constant oscillations of the surface of the water in the boiler will obviate all danger of this occurring.

The Committee, therefore, regarding the invention as useful and ingenious, and believing it to be new, recommend the award of the Scott's Legacy Premium to the Messrs. Dilks for their water gauge.

By order of the Committee,

WM. HAMILTON, *Actuary.*

Philadelphia, February 10th, 1853.

Report on Mr. Richards' Improvement on the Stereoscope.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, an "Improvement on the Stereoscope," invented by Mr. F. De B. Richards, of Philadelphia, Pennsylvania—REPORT:

That, as will be seen by the letter of Mr. Richards, appended hereto, he claims for his arrangement of the Stereoscope four advantages, viz:

First. "Leaving the box open for a short space at the back, so that the light can fall upon the picture properly, when the body is upright." This arrangement is undoubtedly advantageous, inasmuch as it not only relieves the body from a constrained position, but also allows more light to fall upon the picture than can frequently be gained in the usual construction. It is, however, not new, as a very favorite form of the instrument has been the skeleton stereoscope, in which the whole upper part and sides are open to the light.

Secondly. The "increase of the focal distance and power of the lenses, so as to take in much larger pictures than formerly, which pictures I have found by experience have to be taken at a different angle from those for smaller instruments." This enlargement of the capacity of the instrument is undoubtedly in many cases an advantage; but as it is obtained simply by increasing the focal distance and power of the lenses, cannot be considered as an invention, although it may be a very happy suggestion.

Thirdly. "The placing at the back of the instrument a screw, to lessen or increase the distance of the picture from the lenses, so as to suit any focus." The Committee consider this arrangement as constituting a

very great improvement, the ordinary mode of accomplishing this end by drawing out the tube in front, being, as Mr. Richards remarks, apt to throw the lenses out of adjustment, when attempted by those not familiar with the instrument.

Fourthly. "The placing a rack and pinion or lever in front, by means of which the distance between the lenses may be widened or lessened, so as to bring their centres in a line with the centres of the eyes; thus obviating the straining effort which many persons have to use in viewing pictures through the ordinary instrument."

Mr. Richards considers this as the most important of his improvements, and the advantage of it will easily be seen by any one who will try the experiment by altering the adjustment as indicated. It is believed that this means of adjustment has been before applied to opera glasses, but the employment in the stereoscope the Committee consider as new and valuable.

On the whole, the Committee consider Mr. Richards' form of the stereoscope as an ingenious and improved modification of the ordinary instrument, and recommend that a description of it be published in the Journal of the Institute.

By order of the Committee.

WM. HAMILTON, *Actuary.*

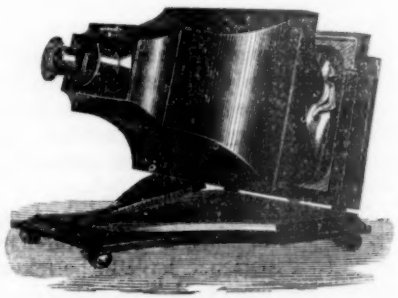
Philadelphia, February 10, 1853.

To the Committee on Science and the Arts of the Franklin Institute.

GENTLEMEN:—I offer for your consideration some explanation of the Stereoscope I had on exhibition at the Franklin Institute, and what I consider my improvements.

1. In the imported instruments, and all that I have seen, the light is admitted to the picture by a small opening at the top; to view the picture, you have to bend the neck and body over, which is a very unpleasant position. This I obviate by leaving the box open for a very short space at the back, so that the light can fall upon the picture properly when the body is upright.

2. I have increased the focal distance & power of the lenses, so as to take in much larger pictures than formerly, which pictures I have found by experience have to be taken at a different angle from those for small instruments.



3. I have placed at the back of the instrument a screw, so as to lessen or increase the distance of the picture from the lenses, so as to suit any focus. The same alteration has been made by drawing out the tube in front: there is a great objection to this, as those not familiar with the instrument are apt to throw the lenses off their centres.

4. That which I consider the most important of all the changes I have made is, placing a rack and pinion or a lever in front, by which means I

widen or lessen the distance between the lenses, so as to bring their centres on a line with the centres of the eyes; thus obviating that straining effort which many persons have to use in viewing pictures in the ordinary instrument.

I remain your obedient servant,

F. DE B. RICHARDS.

Philadelphia, Nov. 4, 1852.

BIBLIOGRAPHICAL NOTICES.

Principles of Organic and Physiological Chemistry. By DR. CARL LÖWIG. Translated by DANIEL BREED, M. D. Philadelphia: A. Hart, late Carey & Hart: 1853.

For many years the principal part of the attention of the most eminent chemists has been given to the subject of Organic Chemistry. The analogies existing between compounds of organic bodies and those which occur between bodies of an inorganic nature, were too many and too close to allow of a doubt that both classes were subject to the same general laws, and that a full exposition of chemical science must comprise them both; while, on the other hand, the differences arising from few elements, the most complicated combinations, and the difficulty or impossibility of forming them at pleasure, indicated the existence of new conditions, and the interference of other attractions.

So great were the difficulties in pursuing these studies, that, although we owe to older chemists many able and valuable memoirs upon isolated groups and genera of organic compounds, no serious attempt to form a theory appears before our own time, when Berzelius, Liebig, Laurent, Dumas, and others propounded various general modes of viewing the complex phenomena of this branch of their science. Partial as was the success of these hypotheses, and manifest as were the discrepancies among them, it became at least certain that a law existed, and might be attained, and the perseverance of the many and able chemists, especially of the German and French schools, has pursued the subject indefatigably and not unsuccessfully.

Among the most eminent of these, the author of the present treatise holds a well recognised place. Science already owes to him an invaluable treatise on the *Chemistry of Organic Combinations*, and in the work before us we are presented with his views as to the theory of the products of these combinations. The treatise is intended rather for the mature student or the Professor, than for the ordinary class of learners; but we are sure that no one of any class whose chemical education has enabled him to read the work, will rise from its perusal without great profit. The views of Prof. Löwig are generally marked by great expansion and clearness, and although there is occasionally a trace of the German disposition to mysticism and over-refinement, yet they are in general simple and forcible. Considered merely as a hypothesis, or a convenient artificial memory for the student, we consider it as the best we have seen, although much meditation and much experimental investigation will be necessary before it can be definitely accepted as the true expression of nature.